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JOURNAL of the ADELAIDE BOTANIC GARDENS

Volume 18 Part 1

6 March 1998

Instructions to Authors

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Papers will be accepted in the following categories:

(a) Plant systematics (Australian and horticultural groups); (b) Descriptive plant morphology, anatomy and ecology; (c) Obituaries, biography and history; (d) Bibliographic studies, book reviews; (e) Botanical illustrations; (f) Noteworthy horticultural contributions. Preference will be given to unpublished material of suitable standard not intended for publication elsewhere.

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(v) Acknowledgements; (vii) References.

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Text references to publications should be indicated as follows: (Smith, 1959), (Smith, 1959, p. 127), Smith (1959) or Smith (1959, pp. 125-208). The final section of the paper, headed 'References', should include only those titles referred to in this way. It should be laid out as follows:

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Bentham, G. (1868). "Flora Australiensis", Vol. 4.(L. Reeve: London).
Baker, J.G. (1898). Liliaceae. In Thiselton-Dyer, W. T. (ed.). "Flora of Tropical Africa", Vol. 7. (L. Reeve: Ashford).

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10–30 specimens should be cited for each species (or subspecific taxon), although this may be varied under certain circumstances. The author may decide whether or not to include dates of collections and the sequence, provided a constant pattern is adhered to throughout a paper.

Authors wishing to cite all specimens seen may list them all in an index to collectors after the style of the "Flora Malesiana" identification lists. Collections not identifiable by a collection number (assigned by either the collector or herbarium) should cite dates.

Correspondence

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The Director, Adelaide Botanic Gardens, North Terrace, ADELAIDE, South Australia 5000.

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A NEW *NICOTIANA* (SOLANACEAE) FROM NEAR COOBER PEDY, SOUTH AUSTRALIA

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Abstract

Nicotiana truncata Symon is described from desert loams in washes and creeklines in the gibber desert between Coober Pedy and Oodnadatta, South Australia. The chromosome number $2n = 36$ is reported.

Introduction

The first collection of this species appears to have been made by E.H. Ising in 1955. The mixed collection included *N. simulans* and was filed under that species. It was seen by P. Horton and thought to be a possible hybrid with *N. glauca* Grah.

The second collection was made by Mr A.C. Robinson during the Biological Survey of the Stony Deserts. It was recognised as something different but the specimen was inadequate. It was next collected by Mr R.J. Bates (*Bates 46914*), who brought back ample material from Fishhole Creek, SW of Oodnadatta. This finding prompted a rapid visit to the area by the author.

Nicotiana truncata Symon, *sp. nov.*

Herba annua (15-) 30 (-50) cm alta. *Folia* rosulata in terra plerumque plana, petiolum 5–12 cm anguste super alatum, laminae plerumque 10 × 7 cm, ovatae, ad basim attenuatae, apice rotundata, glabrae aliquantum carnosae nitidae et virides. *Inflorescentia* paniculata, primo ramo folio subtento, ramis superioribus bractea 3–4 mm longa subtentatis; *pedicellus* 3–5 mm sub anthesi, ad 15 mm in fructu longus; *calyx* 5 mm sub anthesi, tubularis, truncatus, acumenibus 0.5–1 mm longis; *tubus corollae* 15 mm longus 2 mm latus, limbus 10–11 mm latus, lobi rotundati et emarginati, albus; *stamina* quattuor in fauci, quintum in corollae tubo semiadnatum. *Ovarium* 2–2.5 mm, conicum, infra disco carnoso; stylum 14–16 mm longum, stigma breviter bilobatum. *Capsula* c. 10 × 7 mm, apex 2–3 mm longior quam calyx. *Semina* 1 mm, reniformia, grasse reticulata, copiosa. Fig. 1.

Typus: South Australia, shallow silty wash in gibber plain, 36 km SW of Oodnadatta, 1.v.1997, *Symon 15679*. Hardly a creek, no trees, with *Astrebla, Flaveria, Solanum, Goodenia, Tribulus* and *Convolvulus* (Holo.: AD 99721096; iso.: BRI, CANB, K, MEL, MO, NSW, NT, PERTH).

Annual (15-) 30 (-50) cm tall. Petiole 5–12 cm narrowly winged above, glabrous. *Leaves* mostly in a radical rosette flat on the ground, only in large vigorous plants are leaves elevated and one present at the first branch of the inflorescence, lamina commonly 10 × 7 cm, exceptionally 25 × 15 cm, ovate, narrowly cuneate below and continuing along the petiole as a narrow wing, apex rounded, glabrous above and below, somewhat fleshy, shiny green. *Inflorescences* 1–5 or 6, from the rosette, the first branch at about mid point often subtended by a leaf, higher order branches subtended by a bract 3–4 mm long. *Pedicel* 3–5 mm at anthesis lengthening to 15 mm in fruit. *Calyx* 5 mm at anthesis, tubular, truncate, the lobes reduced to acumens 0.5–1 mm long, pedicel and calyx minutely pubescent with glandular hairs. *Corolla tube* 15 mm long, 2 mm diameter, slightly contracted above the ovary and throat cup, slightly expanded about the anthers; *limb* c. 5 mm long, expanded to 10–11 mm diameter, the lobes rounded, slightly emarginate, white. *Stamens* 5, four with short filaments attached at the throat cup, the fifth filament attached to the tube near the ovary apex, its anther remaining below the others. *Ovary* 2–2.5 mm, conical, with subtending disc. *Style* 14–16 mm; stigma shortly bilobed, projecting above the anthers. *Capsule* c. 10 mm long, 7 mm wide, relatively stout, apex projecting 2–3 mm above the

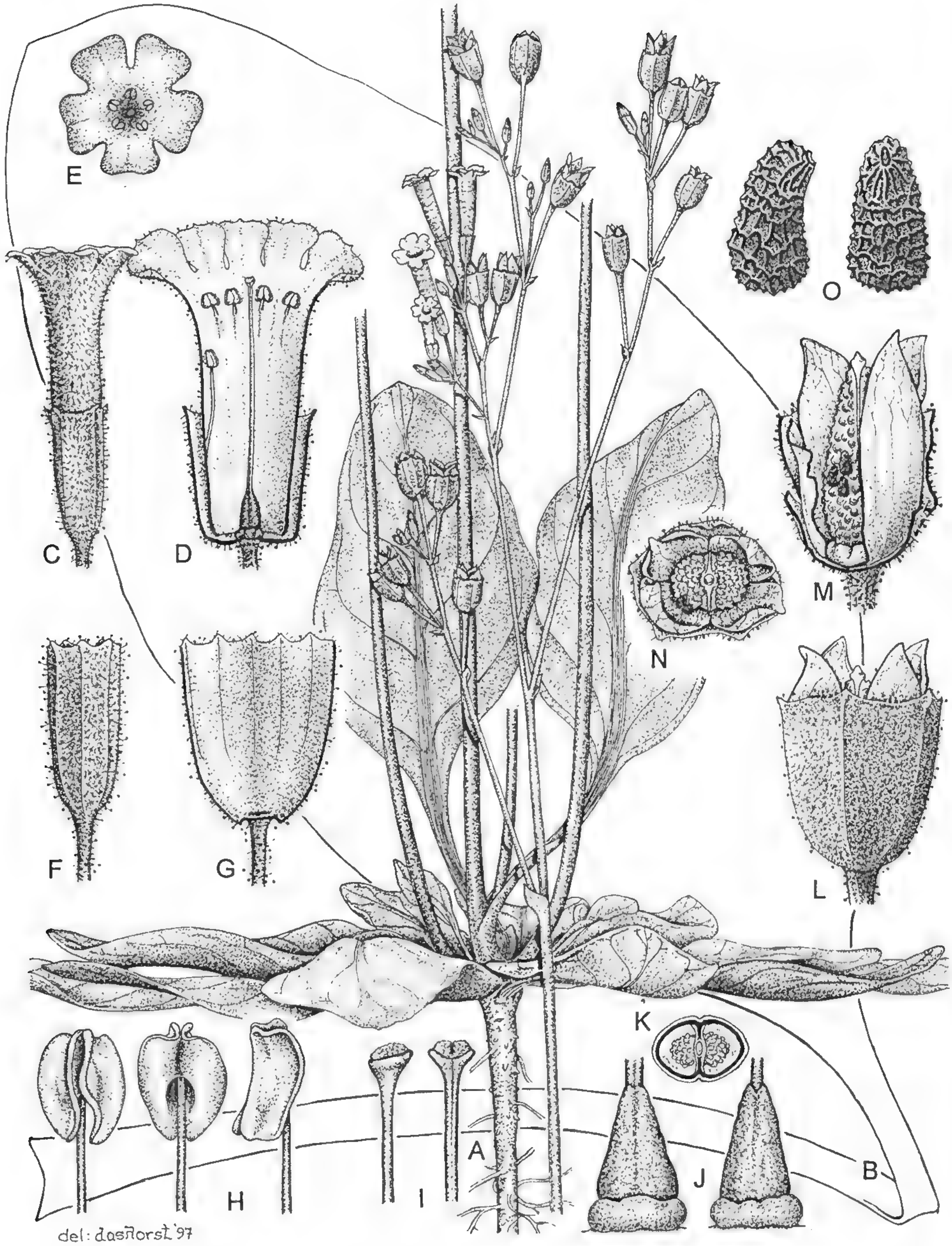

Fig. 1. ***Nicotiana truncata*** Symon (**A–O**, *Symon 15679*: AD). **A**, habit ×1; **B**, leaf in outline ×1; **C**, closed flower ×3; **D**, open flower ×3; **E**, flower viewed from above ×3; **F**, closed calyx ×4; **G**, open calyx ×4; **H**, anther in front, back and side view ×20; **I**, two aspects of style and stigma ×10; **J**, ovary and basal disc ×10; **K**, cross-section through ovary ×10; **L**, dehisced capsule ×4; **M**, dehisced capsule with part of calyx removed ×4; **N**, dehisced capsule viewed from above ×4; **O**, two aspects of seed ×30.

closely investing truncate calyx, valves four. *Seeds* 1 mm long, reniform, coarsely reticulate, abundant. *Chromosome number* 2n = 36.

Diagnostic features

The new species is distinct from all other Australian *Nicotiana* species in its truncate calyx and slightly fleshy, glabrous leaves. The mature capsule approximates that of the introduced *N. glauca*, but in that the calyx lobes, although short, are distinct and the valves scarcely exceed the calyx. The plants are otherwise wholly distinct.

Distribution

The new species was found to be abundant at localised sites between Coober Pedy and Oodnadatta and more of it was collected between 31 km NE of Coober Pedy to Fishhole Creek about 32 km SW of Oodnadatta. The landscape is of shallow undulating gibber plains cut by shallow washes to creek lines of various size that contribute to the Lora, Archaringa and Neales drainage system.

The area is gypseous with plates of glass-like gypsum on shallow banks and exposures. The shallow washes and creek beds often consist of deeply cracking fine silty clay loam. The surface is often puffy and tiring to walk on when dry and almost impossible when wet. The *Nicotiana* was only found on such sites and did not occur on the surrounding gibber plains.

Conservation status

The species is not known to occur in a Conservation Reserve. The area in which it occurs is under Pastoral Lease. The barren landscape is lightly grazed, although there was no sign of grazing activity at the time of collecting. It is suspected that the plants spend much of their time as seed and only appear after very irregular good rains.

Etymology

From the Latin *truncatus*, ending abruptly as if cut across and referring to the distinctive truncate calyx tube.

Note on the chromosomes and figure supplied by Dr J. N. Timmis, Genetics Department, University of Adelaide.

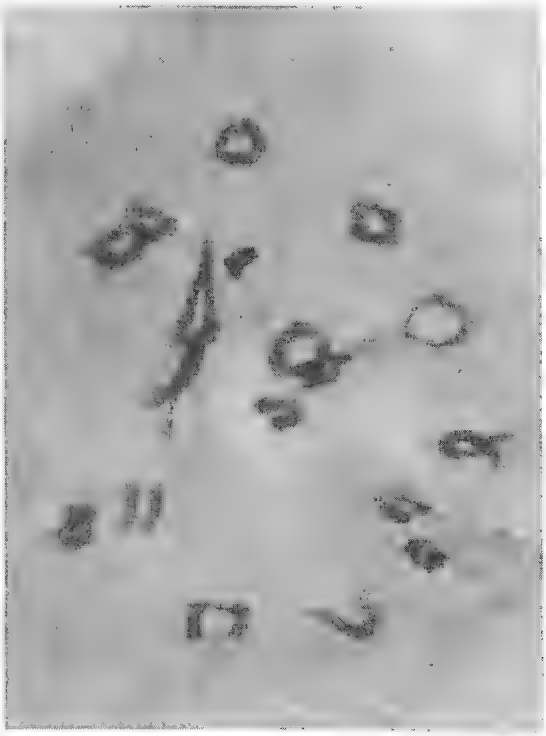

Fig. 2. Meiosis in *Nicotiana truncata*.

Flowering heads were fixed in 3:1 ethanol:acetic acid and transferred to 70% ethanol. Anthers from a single plant were dissected and squash preparations pollen mother cells prepared in acetic orcein. Cells at late diplotene of meiosis were large and their chromosomes well spread (Fig. 2) making them most suitable for chromosome counts. The species contains 36 chromosomes which pair as 18 bivalents with no evidence of irregular or multivalent chromosome associations. This chromosome number and meiotic pairing behaviour suggests that the new species, like most other members of the *Suaveolentes* (Goodspeed, 1954), is a fertile aneuploid derived, possibly

sequentially, by the loss of 6 chromosome pairs from an ancestral allotetraploid species as the genus radiated within Australia. (Voucher *Symon 15665*)

Possible relationships

Nicotiana truncata shares the same chromosome number with *N. amplexicaulis* and *N. gossei* but does not appear closely related to either. the first has a well developed stem to over 1 m high with pubescent leaves, mostly cauline and petiolate below, sessile and auriculate above. The corolla is of comparable size to *N. truncata.* The second is a leafy herb to 2 m, densely pubescent, the leaves mostly cauline. The calyx and corolla are much longer than the flowers of *N. truncata.* Both these species grow in sheltered sites in rocky range systems.

Both *N. rosulata* and *N. goodspeedii* have n = 20 chromosomes and are similar in plant form with the foliage principally in basal rosettes with few cauline leaves. The first is sparingly pubescent but the corolla is longer and more slender. The second is virtually glabrous but the leaves are elliptic to spathulate. The corollas are comparable and *N. goodspeedii* favours alkaline soils. These two species would appear to be morphologically close to the new species despite the difference in chromosome number.

A satisfactory evolutionary tree for the Australian species of *Nicotiana* is yet to be presented. Earlier efforts by Horton & Symon were not satisfactory and not published.

Specimens examined

SOUTH AUSTRALIA: *Ising*, Fish Hole, 20 miles S of Oodnadatta. Growing in swampy ground, 25.viii.1955 (AD); *Robinson D.E.N.R. 27531*, 8.3 km NE of Nasa Bore, 27°45'15", 135°14'18". Stream channel in stony desert, deep cracking gypseous clay. Open grassland with *Eragrostis setifolia* and *Iseilema vaginiflora* (AD); *Bates 46914*, Fishhole Creek, common at Fishhole creek on gypseous clay after floods. Annuals to 50 cm high, pretty white flower, distinctive calyx tube, rosettes. Not much else present except *Typhonium*, 18.iv.1997 (AD); *Symon 15665*, Giddie Giddinna Creek, 46 km NE of Coober Pedy on road to Oodnadatta. Heavy fine silty loam, deeply cracking gypseous soils, 30.iv.1997 (AD, BRI, NSW, NT, PERTH); *Symon 15671*, Fishhole Creek, 32 km SW of Oodnadatta, 30.iv.1997 (AD, CANB, CORD, K, MO, NY); *Symon 15675*, shallow creek lines at base of gibber slope 34 km SW of Oodnadatta, 30.iv.1997 (AD).

The new species may be inserted into the Key to *Nicotiana* in Vol. 29, Flora of Australia on page 44 as follows. After lead 7, "Flowering stems leafless, ..." insert:-

7a Calyx truncate, the lobes reduced to acumens about 1 mm long, capsule exposed....................... *N. truncata*
7b Calyx lobes clearly developed, mostly equal to or exceeding the capsule.
8 Cauline leaves decurrent on the stem ...

Acknowledgements

I am grateful to R.J. Bates who drew my attention to the new species, to G.R.M. Dashorst for the illustrative plate, Mary Marlow for the Latin and Dr J.N. Timmis for the chromosome count and photograph.

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BULBIL WATSONIA IS A VARIETY OF *WATSONIA MERIANA* (L.)MILLER (IRIDACEAE)

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Abstract

Bulbil watsonia, formerly known as *Watsonia bulbillifera* or as *W. meriana* cultivar 'Bulbillifera', is more appropriately treated as *W. meriana* var. *bulbillifera*, stat. nov.

A distinct weedy *Watsonia*, known as bulbil watsonia, is an invader of native vegetation and pasture in southern Australia. It also occurs as a weed in South Africa (Goldblatt, 1989) and New Zealand. It falls within the circumscription of the widespread and variable South African species *Watsonia meriana* (L.)Miller in most characters (Goldblatt, 1989), but was described as the species *W. bulbillifera* by Mathews and Bolus (1922) because it produces cormils in the inflorescence.

Since one clone of bulbil watsonia was found to be triploid by Goldblatt (1971), it has been assumed to be dependent on vegetative reproduction. However, partially fertile plants producing a few capsules with fully developed seeds were reported by Mathews & Bolus (1922) at the type locality, and by Wilson (1993) in South Australia. The latter observed that although fruit set was about 65 percent, seed set was only of the order of one percent. Because at least some of these seeds are viable, the possibility of the occurrence of polyploidy and/or apomixis in the South Australian populations is currently under investigation (J. Conran pers. comm.).

Bulbil watsonia does not consist of a single uniform clone. The flower colour in Australian specimens varies from a dark red to a pale salmon-pink or orange, and the inflorescence also varies in the extent to which lateral branches are developed. These variations imply either sexual reproduction or a polyphyletic origin of bulbil watsonia. In view of the occurrence of very occasional individuals producing both seed and bulbils, represented by *D. Cooke 726*, in a large and variable population of *W. meriana* at in the Mount Lofty Ranges, the latter hypothesis is more likely.

Goldblatt (1989) reduced *W. bulbillifera* to a cultivar of *W. meriana* because it does not form wild populations except in localities where it is likely to be a garden escape, and was first noticed among feral and cultivated populations of this species in the 19th century. Goldblatt (pers. comm.) suggests this occurred around Paarl on the Cape Flats.

However, there is no evidence to suggest that bulbil watsonia is a product of artificial selection for ornamental values. It is a less desirable ornamental plant than diploid *W. meriana*, being taller but with fewer flowers widely spaced in an inflorescence that usually has poorly developed branches. The selective breeding of *Watsonia* cultivars from *W. meriana* and other species has been consistently towards denser inflorescences, and generally toward shorter plants. The tall persistent stems, sparse flowering and prolific vegetative reproduction of bulbil watsonia are all disadvantages from the gardener's viewpoint.

Bulbil watsonia is more likely to have been present in mixed populations of corms collected from the wild or to have originated among seedlings of *W. meriana*. It would have multiplied spontaneously and unnoticed in gardens at the expense of diploid *W. meriana* because it reproduced more efficiently by aerial cormils.

Bulbil watsonia does not conform to the definition of cultivar as "an assemblage of cultivated plants..." (International Code of Nomenclature for Cultivated Plants, 1980). This definition is usually interpreted (eg. Jeffrey, 1982; Hetterscheid & Brandenburg, 1995) to cover only cultigens or other kinds of plants maintained solely by cultivation, since cultivated specimens of wild taxa retain the same specific or infraspecific epithet as the wild populations. By analogy with other weeds that have evolved by natural selection within environments modified by human activities, bulbil watsonia is more appropriately treated as a wild taxon than as a culton (sensu Hetterscheid & Brandenburg, *l.c.*) produced by artificial selection or other human intervention. However, its close and complex relationship to *W. meriana* makes the rank of species also inappropriate. I have therefore taken the middle course of proposing it as a variety of *W. meriana.*

Watsonia meriana (L.)Miller var. ***bulbillifera*** (J. Mathews & L. Bolus)D.A. Cooke, *stat. nov.*

Basionym: *Watsonia bulbillifera* J. Mathews & L. Bolus, Ann. Bolus Herb. 3: 140 (1922). *Watsonia meriana* 'Bulbillifera' (J. Mathews & L. Bolus) Goldblatt, Ann. Kirstenbosch Bot. Gard. 19: 123-124 (1989).

Type: South Africa, Cape Joostenberg, s.coll. (lecto.: Nat. Bot. Gard 707/1 in BOL fide Goldblatt (1989) p. 120).

Inflorescence 100-210 cm high with 10-15 flowers on the main axis; bracts in the lower part of the spike subtending subglobose clusters of 4-12 tunicate cormils in place of flowers, sometimes the upper bracts with a few cormils in addition to a normally developed flower. Perianth tube 45-50 mm long. Capsules rarely produced.

Selected specimens examined

WESTERN AUSTRALIA: *R.D. Royce 4705*, Bellevue, (PERTH).

SOUTH AUSTRALIA: *D.Cooke 662*, roadside W of Donnybrook, 17.xi.1993, (ADA 4485); *D.Cooke 726*, Freeway at Bridgewater, 7.xi.1996, (AD).

NEW SOUTH WALES: *T.Barratt s.n.*, North Turramurra near Kuringai Chase, 19.x.1960, (NSW).

SOUTH AFRICA: *G.J. Lewis 5305*, Breede River 8 miles W of Worcester, 4.xi.1958 (AD98661875)

NEW ZEALAND: *A.E. Orchard 3585*, 6 km N of Keri Keri, North Island, 13.x.1972 (AD97250371).

Watsonia meriana (L.)Miller var. *meriana*
Watsonia sp. B D.A. Cooke, Flora of Australia 46: 42 (1986).

Inflorescence 50-210 cm high with 10-25 flowers on the main axis, never bearing cormils. Perianth tube 35-50 mm long. Capsules frequently produced.

Selected specimens examined:

WESTERN AUSTRALIA: *T.E.H. Aplin 1200*, Waroona, (PERTH); *R.D.Royce 3901*, Yoongarillup, Busselton district, (PERTH).

SOUTH AUSTRALIA: *D. Cooke 601*, South-eastern Freeway S of Hahndorf, 12.xi.1990, (ADA 4367); *D. Cooke 723*, Freeway at Bridgewater, 7.xi.1996, (AD); ibid., *D. Cooke 720* (AD); Blackwood, n.coll., 31.x.1933 (ADA 12186).

The only reliable morphological distinction between the two varieties is the replacement of the lower flowers by cormil clusters in var. *bulbillifera.*

Each cluster of inflorescence cormils is homologous to the flower that it replaces. They can be clearly differentiated from the solitary cormils produced in the lower leaf axils of

some populations of var. *meriana* and some garden hybrids derived from this variety. In *Watsonia*, unlike most genera of Ixieae where a corm is formed from the base of the flowering shoot, growth is strictly sympodial: the shoot dies completely after flowering and all new corms are formed in the axils of cataphylls (Goldblatt, 1990). Cormils produced above ground in the axils of foliage leaves are therefore serially homologous to the underground corms. They are not uncommon in the genus, occurring for example a biotype of *W. aletroides* (Burm.f.)Ker Gawler cultivated in Australia.

Mixed populations of the two varieties occur in Australia, but var. *bulbillifera* is much more common and usually grows in pure stands.

It is also possible that the partially fertile populations of var. *bulbillifera* are triploid clones producing seed by apomixis, but in this case full fertility might be expected; they may also be hexaploids derived from sterile triploids. An alternative hypothesis is that var. *bulbillifera* originated from var. *meriana* as an autotetraploid, in which partial fertility would be expected. This autotetraploid could then have crossed with various biotypes of the diploid var. *meriana* to produce many triploid clones, accounting for the the minor variations noted above.

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SOIL CRUST LICHENS AND MOSSES ON CALCRETE-DOMINANT SOILS AT MARALINGA IN ARID SOUTH AUSTRALIA

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Abstract

A total of 23 lichen and six moss taxa were collected from soil crusts at 15 sites on calcrete-dominant landscapes in the Maralinga area. Apart from two vagant lichens *Chondropsis semiviridis* (F. Muell. ex Nyl.)Nyl. and *Xanthoparmelia convoluta* (Krempehl.)Hale, soil lichens were dominated by crustose and squamulose types. Three families, Verrucariaceae, Peltulaceae and Lecideaceae accounted for 57% of the genera found at Maralinga. No liverworts, and only six moss species were collected. Sites with varying disturbance history were used to examine the recovery of crust cover and floristics over time. Across all quadrats, crust cover (± standard error of the mean) averaged 38.0 ± 3.6%. Total crust cover and lichen species richness increased significantly as time since disturbance increased (P<0.001). Field results suggest that recovery of crust cover to levels necessary for protection against water erosion (30–40% cover) is achievable within 30–40 years.

Introduction

Maralinga lies between the Nullarbor Plain and the Great Victoria Desert approximately 800 km north-west of Adelaide. In the mid 1950s the area around Maralinga was used for nuclear testing, and for the past 40 years, access has been restricted. The landscape comprises a mosaic of semi-arid woodland and low shrubland, which, apart from small areas immediately adjacent to the nuclear test sites, has been altered very little by europeans. The soils are rich in calcareous sediments, and exposed calcrete is common on the surface. The combination of winter-dominant rainfall, highly calcareous soils and low levels of disturbance has supported the growth and establishment of an extensive microphytic crust cover over large areas of the landscape. This crusted surface protects the soil against wind and water erosion (Williams *et al.*,1995; Eldridge and Kinnell, 1997), and is essential for the maintenance of vital soil and ecological processes (West, 1990; Eldridge and Greene, 1994a).

Because of its extreme isolation and restricted access, relatively few plant collections have been made from the area. Although soil crust lichens and mosses abound, there are few collections of non-vascular organisms from the Maralinga area, and specimens from the Nullarbor and North-western Regions are poorly represented in herbarium holdings.

In August 1996 a visit was made to the area to examine recovery of disturbed soil crusts in order to predict their recovery rates after the current cleanup of contaminated soils. This paper describes the lichens and mosses found during a systematic survey of soil crusts at 15 sites north of Maralinga Village across a range of disturbance histories.

The Study site

Maralinga is located approximately 800 km north-west of Adelaide in the North-western and Nullarbor Regions. The area lies midway between the Great Victoria Desert in the north, and the Nullarbor Plain in the south-west and consequently includes a mixture of plain and dunefield landscapes. Since the early 1950s, access to the area has been severely restricted due to its history of nuclear testing. Prior to that time much of the area was under traditional ownership by the local Maralinga-Tjarutja aborigines. Due to the relatively low

rainfall, lack of reliable surface water and location outside the Dog Fence, the area has not been used for cattle grazing or sheep grazing respectively.

i) Climate

The Maralinga area is typical of arid Australia in that it receives approximately 200 mm yr^{-1} (Meigs, 1953). This rainfall is extremely spatially and temporally variable. To the south the township of Cook has an average annual rainfall of 172 mm yr^{-1}. Winds at Maralinga are generally light to moderate, and the area receives some cool W-SW winds from the Great Southern Ocean 150 km to the south. Climate ranges from cool winters with overnight dews and frosts to hot summers where diurnal temperatures in excess of 40°C are not uncommon (Trefry, 1979).

ii) Geomorphology

Most of the area is underlain by calcrete, derived from Middle Miocene Tertiary limestone. Consequently, soils are highly calcareous, with pH levels often in excess 9.0. The relatively open areas where most of the nuclear testing was carried out comprise low, gently undulating plains dominated by loamy calcareous soils, often with exposed calcrete at the surface. To the north, these plains merge into the southern limits of the Great Victoria Desert which comprises linear, west-east trending sand dunes which rise up to 8 m above the surrounding landscape. The dunes are separated by moderately wide swales to 2 km wide with local slopes to 1–2%. The dune soils are predominantly uniform sands and loamy sands, with little or no profile development. The swales (or dongas) represent shallow, subcircular depressions with gentle slopes and flat valley floors. These swales are frequently arranged in chains, parallel to the neighbouring dune systems, but elsewhere appear to have a random spatial pattern (Jennings, 1967). The swales comprise a mixture of calcareous loams and sandy loams, often with weak pedological development (Mitchell *et al.*, 1979), grading to sands and loamy sands at the margins of the dunes.

iii) Vascular vegetation

The predominant vegetation on calcareous soils is a semi-arid low woodland dominated by mulga (*Acacia aneura*), bullock bush (*Alectryon oleifolius*), sugarwood (*Myoporum platycarpum*), mallees (*Eucalyptus gracilis, E. foecunda, E. socialis*), *Senna artemesioides* and numerous acacias (*A. burkittii, A. colletioides, A. kempeana, A. oswaldii, A. papyrocarpa*). The sand dunes are dominated by mallees as well as isolated bullock bush and shrubs of the Chenopodiaceae (*Atriplex* spp., *Maireana* spp.).

Methods

In August 1996 a field trip was made to the Maralinga area to examine natural regeneration of microphytic crust surfaces in relation to disturbance history, and to make collections of soil crust lichens, bryophytes and cyanobacteria. Fifteen sites were visited, each with a known disturbance history. These sites included areas never disturbed (or relatively undisturbed) by Europeans, tracks constructed during nuclear testing operations in 1956 and left to regenerate, sites disturbed in 1967 during Operation Brumby and left to regenerate, and an area disturbed in 1993. Sites were chosen on the basis of local knowledge and information held in unpublished and published reports and files. At each of the 15 sites, a 100 m transect was laid out perpendicular to the road, and ten 0.5 m^2 quadrats were laid down to form the basis for data and soil crust collection. Within each quadrat, measurements were made of soil surface condition, microtopography, landscape element, slope, type and degree of erosion, cover and relative composition of lichens and bryophytes, cover and type of vascular plants, and cover and type of litter. Relationships between surface morphology, vascular plants and lichen and bryophyte taxa are reported elsewhere. Samples of soil crust were collected from each quadrat and transported to the

laboratory to enable the lichens and bryophytes in the samples to be identified. Sufficient material was collected to provide voucher material for lodgement in various herbaria. Additional samples of taxa recorded at a site, but not collected in the 10 quadrats, were also made.

Soil samples were sieved in the laboratory using a 2 mm sieve. Lichens and bryophytes were identified using keys in Filson (1988, 1992), Filson and Rogers (1979), McCarthy (1991a), Catcheside (1980) and Scott and Stone (1976), as well as more recent generic revisions. Nomenclature follows Streimann and Curnow (1989) and McCarthy (1991b).

Results

i) Crust floristics

Apart from one site which was disturbed in 1993, surfaces supported a rich flora of terricolous lichens. Across the 15 sites (150 quadrats), 23 lichen and 6 moss species were recorded. Three lichen families, Verrucariaceae, Peltulaceae and Lecideaceae accounted for 57% of the genera found at the 15 sites. Nine species, *Catapyrenium lacinulatum* (Ach.)Breuss, *C. squamulosum* (Ach.)Breuss, *Collema coccophorum* (Tuck.), *Eremasterella crystallifera* (Taylor)G. Schneider, *Fulgensia subbracteata* (Nyl.)Poelt, *Heppia despreauxii* (Mont.)Tuck., *Peltula patellata* (Bagl.)Swinscog & Krog ssp. *australiensis* (Muell.-Arg.)Büdel, *Psora crenata* and *Lecidea* sp. aff. *ochroleuca* Pers. were collected at ten or more of the sites. Apart from the two foliose and vagant lichens *Chondropsis semiviridis* and *Xanthoparmelia convoluta*, the soil crust was dominated by crustose and squamulose lichens. Other terricolous lichens found in the general area but absent from the 150 quadrats included: *Xanthoparmelia constipata* (Kurokawa & Filson)Elix & Johnston, × *alternata* Elix & Johnston, infertile *squamules* of *Cladonia* sp. and *Neofuscelia luteonotata* (J. Stein)Esslinger. The saxicolous lichens *Buellia subalbula* (Nyl.)Muell.-Arg., *Peltula omphaliza* (Nyl.)Wetmore, *Diploschistes gypsaceus* (Ach.)Zahlbr., *Lecanora sphaerospora* Muell.-Arg., *Acarospora glaucocarpa* (Ach.)Korber and *Caloplaca* sp. aff. *cinnabarina* (Ach.)Zahlbr. were common components of calcareous rocks at many sites.

Six moss species were collected from the 150 quadrats. Many of the mosses came from the families Pottiaceae and Bryaceae (Table 1). Three of these, *Desmatodon convolutus*

	*No. of quadrants	Years since disturbance			
		3	30	40	99
LICHENS					*
Acarospora nodulosa (Dufour)Hue	5		*	*	*
A. novae-hollandiae H. Magn.	8			*	*
Aspicilia calcarea (L.)Mudd.	19				*
Caloplaca sp.	1		*	*	*
Catapyrenium lacinulatum (Ach.)Breuss	36			*	*
C. pilosellum Breuss	2		*	*	*
C. squamulosum (Ach.)Breuss	60				*
Chondropsis semiviridis (F. Muell. ex Nyl.)Nyl.	8		*	*	*
Collema coccophorum Tuck.	134				*
Diploschistes thunbergianus (Ach.)Lumbsch & Vezda	3			*	*
Endocarpon helmsianum Muell.-Arg.	6		*	*	*
E. pusillum Hedw.	18		*		
E. rogersii P.M. McCarthy	1		*	*	*
Eremastrella crystallifera (Taylor)G. Schneider	47		*	*	*
Fugensia subbracteata (Nyl.)Poelt	45		*	*	*

Table 1. Relationships between time since disturbance and presence or absence of lichens and mosses averaged over the relevant number of quadrats at each site. *maximum = 150.

Table 1 cont.

	*No. of quadrants	Years since disturbance			
		3	30	40	99
LICHENS cont.					*
Heppia despreauxii (Mont.)Tuck.	95		*	*	*
Lecidea sp. aff. *ochroleuca* Pers.	40				*
Peltula imbricata R. Filson	1		*	*	*
P. patellata (Bagl.)Swinscow & Krog subsp. *australiensis* (Muell.-Arg.)Büdel	48		*	*	*
Psora crenata (Taylor)Reinke	71		*	·	*
Toninia sedifolia (Scop.)Timdal	8				*
Xanthoparmelia convoluta (Krempelh.)Hale	3				
MOSSES					
Acaulon leucochaete Stone	6		*	*	*
Bryum eremaeum Catches. ex Spence & Ramsay	49		*	*	*
Crossidium davidai Catches.	3		*	*	*
C. geheebii (Broth.)Broth.	11		*	*	*
Desmatodon convolutus (Brid.)Grout	70		*	*	*
Stonea oleaginosa (Stone)R.H. Zander	36		*	*	*

(Brid.)Grout, *Stonea oleaginosa* (Stone)R.M. Zander and *Bryum eremaeum* (Catch. ex Stone & Ramsay were collected from 10 or more sites. *Desmatodon convolutus* and *Bryum eremaeum* were the most abundant mosses in the area. Other mosses collected within the quadrats included *Crossidium geheebii* (Broth.)Broth., *Crossidium davidai* Catches., *Acaulon leucochaete* Stone and a sterile unidentified *Pottia* sp. Other species found outside the quadrats, usually as isolated individuals, included *Goniomitrium enerve* Hook. & Wils., *Didymodon torquatus* (Tayl.)Catches. and *Tortula princeps* De Not. Small tufts of *Bryum* argenteum Hedw. were found amongst building debris at the Maralinga Village. Despite exhaustive searching in suitable habitats, and moderate rainfall prior to and during the collecting trip, no hepatics were collected in either the quadrats or in adjacent areas.

Species richness of lichens on their own was a useful indicator of disturbance history (Table 2). There was a significant increase in the total number of lichen species as time since disturbance increased ($F_{1,148}$=132.45, P<0.001), and time since disturbance explained 47% of the variation in number of species. Adding the number of mosses to lichens failed to explain any more of the unexplained variability in time since disturbance.

Years since disturbance	Number of quadrats	Number of taxa	
		Mean	SEM
3	10	0.0	0.0
30	50	5.08	0.36
40	40	7.48	0.41
100	50	9.55	0.37

Table 2. Mean and standard error of the mean (SEM) number of lichen taxa for sites of varying disturbance history on calcrete soils at Maralinga.

ii) Crust cover

Total cover of microphytic soil crust ranged from zero to 90% across the 150 quadrats. Across all sites and quadrats, mean cover (± standard error of the mean) of microphytic crusts was 38.0 ± 3.6 %. There was a significant effect of time since disturbance on crust cover ($F_{3,146}$=14.56, P<0.001) with crust cover increasing with time since disturbance (Figure 1). However, time since disturbance accounted for only 28% of the variation in

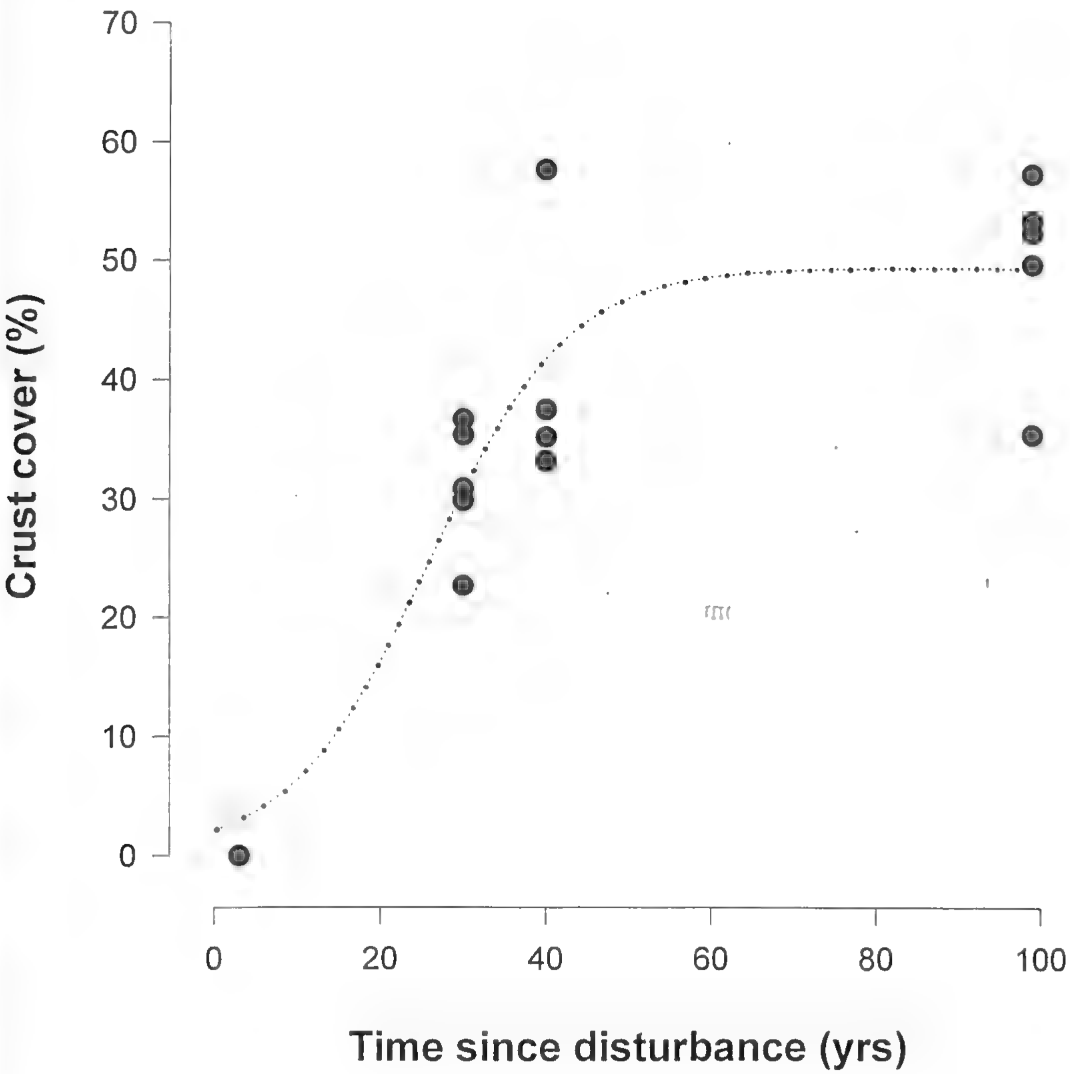

Fig. 1. Changes in crust cover (%) with changes in time since disturbance.

crust cover. This was probably due to the fact that there is a rapid increase in cover of cyanobacteria and cyanolichens such as *Peltula* and *Collema* shortly after disturbance so that examination of cover alone is a poor indicator of the dynamics of soil crust recovery.

Discussion

The Maralinga soils yielded a rich suite of 22 lichen taxa, nine of which occurred at ten or more sites (Table 1). Surprisingly the bryophyte flora was dominated by only four moss species, and no liverworts were found at the sites. Six terricolous lichens were found only in areas which have not been disturbed. These included the foliose lichens *Chondropsis semiviridis* and *Xanthoparmelia convoluta*, and the crustose and squamulose lichens *Caloplaca* sp., *Peltula imbricata* R. Filson, *Acarospora nodulosa* (Dufour)Hue and *Diploschistes thunbergianus* (Ach.)Lumbsch & Vezda.

The high surface coverage of the crusts in the Maralinga area is attributed to a combination of high soil pH levels and low levels of disturbance. In other semi-arid and arid regions, calcareous soils also support extensive areas of crust, often with a large number of species. For example Eldridge (1996) showed that in western NSW, the largest number of lichen and bryophyte species (up to 16 per 0.5 m^2 quadrat) occurred on calcareous earth soils. Similarly, Anderson *et al.* (1992) and St Clair *et al.* (1993) demonstrated the importance of soil pH in explaining the distribution of bryophytes and lichens in soil crusts in the western United States. In western NSW, Downing and Selkirk (1993) showed that calcareous soils along the Lake Mungo shoreline, and the belah-rosewood woodlands, supported the greatest number of bryophyte species.

Soil crusts are known to be susceptible to physical disturbances such as trampling by humans, livestock and off-road vehicles (Rogers and Lange, 1971; Mack and Thompson, 1982; Johansen and St Clair, 1986; Beymer and Klopatek, 1992; Jeffries and Klopatek, 1987; Harper and Marble, 1989; Klopatek, 1993). Due to the extreme remoteness of the Maralinga site, the absence of above-ground water, and its location outside the dingo fence, the area has not supported permanent sheep and cattle grazing. Apart from feral camels which are known to inhabit the area, the soil surface has been relatively unimpacted by europeans or introduced animals. Only small areas were used for the atomic tests in the mid-1950s. Similarly the lack of reliable surface water means that the Maralinga-Tjarutja community traditional owners lead a semi-nomadic lifestyle, making only a localised impact upon the soil crust community. Consequently, the soil crust organisms in this area are probably indicative of pristine crust communities.

The lichen crust was dominated by six species *Psora crenata*, *Collema coccophorum*, *Catapyrenium squamulosum*, *Catapyrenium lacinulatum*, *Heppia despreauxii* and *Fulgensia subbracteata* which have large continental and intercontinental distributions. They are common components of crusts in North America (Nash *et al.*, 1977; St Clair *et al.*, 1993), Israel (Galun and Reichert, 1960) and North Africa (Faurel *et al.*, 1953). Two species, *Eremastrella crystallifera* and *Peltula patellata* subsp. *australiensis* are endemic to Australia, and were significant components of the soil crust both in terms of abundance and cover. Three of the six mosses found in the Maralinga area were collected within more than 25% of quadrats. *Stonea oleaginosa* is a small reddish-coloured moss which is often overlooked in soil crust studies (Eldridge and Tozer, 1996). The red apices of the leaves often blend in with the red sand grains on which it grows, and it is often found partially buried in the soil. It is usually associated with stable, uneroded, well-vegetated calcareous soils (Eldridge and Tozer, 1997a). Lipids in the leaves (Stone, 1978) as well as the reddish coloured leaf tips, may assist in thermoregulation. *Desmatodon convolutus* is a common moss associated with soil crusts, and has a large continental distribution ranging from arid winter rainfall-dominant environments to semi-arid, summer rainfall-dominant landscapes (Eldridge and Tozer, 1996). Extensive surveys from western NSW suggest that it is one of the mosses most strongly associated with lichen-dominated soil crusts (Eldridge and Tozer, 1997b). Similarly, *Bryum eremaeum* was found on most surfaces, and is remarkable in that it is restricted almost exclusively to desert regions (Spence and Ramsay, 1996). Underground stem tubers are thought to enable this moss to survive periods of drought (Spence and Ramsay, 1996).

Apart from the present study, there have been few collections from the area. Symon and Copley (1986) recorded 14 bryophyte and 4 lichen species (Table 3) from the Eastern Great Victoria Desert region. Of those recorded, *Heterodea muelleri* (Hampe)Nyl. was the only lichen not found in the present study. The reason for the low number of mosses found in the present study may relate to the relatively homogeneous landscapes on which the study was conducted. No depressions were sampled which may have yielded *Riccia* spp. and *Funaria* spp. which favour saline swamps and saltmarshes (Catcheside, 1980). Census records from the State Herbarium of South Australia for the Nullarbor and North-western Regions (unpublished data) reveal a relatively species poor flora of 27 mosses, 11 liverworts and 21

lichens associated with soil surfaces. Of particular interest is the large number of *Riccia* spp. (9 species) collected from this arid region of South Australia. Many of these were collected during an Adelaide Herbarium expedition to the Birksgate-Tomkinson Ranges in 1978.

LICHENS	MOSSES	LIVERWORTS
Acarospora schleicheri (Ach.)Massal.[1]	*Bryum argenteum* Hedw.	*Riccia lamellosa* Raddi
Heterodea muelleri (Hampe)Nyl.	*B. eremaeum* Catch. ex Spence and Ramsay	
Psora decipiens (Hedw.)Hoffm.	*B.* sp. aff. *pachytheca*	
Xanthoparmelia sp.	*Crossidium davidai* Catches.	
	C. geheebii (Broth.)Broth	
	Desmatodon convolutus (Brid.)Grout	
	Didymodon torquatus (Tayl.)Catches.	
	Funaria hygrometrica Hedw.	
	F. salsicola C. Muell.	
	Gigaspermum repens (Hook.)Lindb.	
	Goniomitrium acuminatum Hook. & Wils.	
	Tortula pagorum (Milde)De Not	
	T. princeps De Not	

Table 3. Lichens, mosses and liverworts collected in the Great Victorian Desert (after Symon and Copley 1986). [1]syn. *Acarospora citrina*.

Apart from the species found on calcareous soils, a number of mosses and lichens were also common on sands associated with mallee (*Eucalyptus* spp.) sandplains and dunefields at Maralinga. Although no objective assessment of abundances was carried out, systematic searches at six sites revealed a rich crust in some areas supporting up to 15 taxa (Table 4). Most sandplain sites were dominated by *Barbula calycina* Schwaegr, *Didymodon torquatus* and *Collema coccophorum*, and crust cover was greatest on the southern side of the trees and shrubs. *Neofuscelia luteonotata* (J. Stein)Esslinger was found at four sites dominated by *Triodia irritans*.

LICHENS	MOSSES
Acarospora citrina (Taylor)Zahlbr. ex Rech.*	*Barbula calycina* Schultz
Catapyrenium squamulosum (Ach.)Breuss	*Bryum eremaeum* Catches. ex Spence & Ramsay
Cladonia sp.	*Didymodon torquatus* (Tayl.)Catches.
Collema coccophorum Tuck.	*Tortula princeps* De Not
Heppia despreauxii (Mont.)Tuck.	
Lecidea sp.	
Neofuscelia luteonotata (J. Stein)Esslinger	
Peltula patellata (Bagl.)Swinscog & Krog	
Psora crenata (Taylor)Reinke	
Xanthoparmelia alternata Elix & Johnston	
X. constipata (Kurokawa & Filson)Elix & Johnston	

Table 4. Mosses and lichens found on sandy soils associated with mallee (*Eucalyptus* spp.) plains and dunefields. *Single specimen only.

Soil crusts and land stability

During the past decade, research in eastern Australia has shown that soil crusts are important for preventing water erosion in rangelands (Eldridge and Greene 1994a,b; Eldridge and Kinnell 1997). Crusts reduce erosion in two main ways. Firstly, soil fungi

associated with crusts glue together small soil particles with their organic gels and polysaccharides, making them relatively stable. Secondly, crusts organisms provide a physical barrier on the soil surface which reduces the erosive energy of raindrops, and densely-packed lichens create small depressions which trap runoff water and allow it to infiltrate into the soil.

Crusts also influence, and this depends on crust composition and soil conditions. Recent research (Eldridge 1993, Eldridge *et al.* 1997) suggests that water flow through soil crusts depends on the physical condition of the soil under the crusts. On well-managed soils with abundant large air pores (macropores), which are usually created by soil animals and plant roots, infiltration is likely to be unaffected by crust cover. However, on degraded soils, fungal hyphae and the roots (rhizines) of lichens help to stabilise the small entry points through which water can enter the soil.

Lichens having cyanobacteria as their fungal partner produce nitrogen which is used by either plants (Belnap 1995) or small soil animals. Crusts also produce organic carbon which is important for binding soil particles together. This increased stability and the fact that crusts trap water and plant seeds, and produce nitrogen, means that crusted soils are good sites for germination and establishment of seedlings (Harper and St Clair 1985) and as refugia for invertebrates such as springtails and mites (Scarlett 1994).

Crusts are often destroyed by livestock trampling and human activities. The lack of disturbance over a large area of the Maralinga site contributes to the extensive crust cover and large number of lichen species found (Table 1). Although sites with 30 or 40 years of recovery have still not recovered their full complement of species, i.e. lacking the foliose lichens *Chondropsis semiviridis* and *Xanthoparmelia convoluta*, they are nevertheless floristically rich. Areas disturbed by the current rehabilitation process are likely to exhibit high rates of erosion before a sufficient vascular and non-vascular plant cover has restabilised. Given the observed pattern of crust recovery over time (Figure 1), it is suggested that recovery to 30–40% cover, a level necessary to protect the soil against water erosion in the absence of vascular plants (Eldridge and Kinnell, 1997), will take from 30 to 40 years.

Annotated list of soil crust taxa

This list includes a frequency score and relevant notes. Species frequency is described as follows: infrequent, less than 5 occurrences i.e. recorded in less than 5 quadrats; relatively infrequent, 5–20 occurrences; common 21–70 occurrences; abundant, >60 occurrences.

Lichens

Acarospora nodulosa (Dufour)Hue Relatively infrequent; found in five quadrats at four of the undisturbed sites. Squamules typically dark cream to light brown coloured, in colonies up to 5 cm across. Fertile squamules characterised by punctiform dark black immersed apothecia were commonly observed. This species has been recorded infrequently on non-calcareous loams in western New South Wales, and also occurs in Western Australia.

Selected specimen examined:

SOUTH AUSTRALIA: *D.J. Eldridge 3513,* 23.viii.1996, calcareous rocky ridge approximately 18 km N Maralinga Village, with dense *Acacia aneura* and *Casuarina cristata*, in association with *Toninia sedifolia, Eremastrella crystallifera* and *Heppia despreauxii.*

Acarospora novae-hollandiae H. Magn. Relatively infrequent. Large patches of this typically yellow-green crustose lichen occurred on calcareous soil at five of the fifteen sites across a range of disturbance histories (Table 1).

Selected specimen examined:

SOUTH AUSTRALIA: *D.J. Eldridge 3536*, 25.viii.1996, on calcareous plains of *Casuarina cristata*, *Acacia colletioides* and *Maireana astrotricha* with *Peltula* patellata ssp. *australiensis*, *Catapyrenium* lacinulatum and Psora crenata, 1 km S of junction of Left St and Second St, approx 35 km N Maralinga Village.

Aspicilia calcarea (L.)Mudd Relatively infrequent. Although *Aspicilia calcarea* was generally restricted to undisturbed sites, it was also recorded on one site with 40 years recovery. Specimens were typically grey to greyish-white, tubular to coral-like, varying to sub-fruticose in some areas. Sub-fruticose forms were typically attached to rock as well as soil. No fertile specimens were observed.

Selected specimen examined:

SOUTH AUSTRALIA: *D.J. Eldridge 3543,* 25.viii.1996, calcrete plains at the junction of Boona Radial and 2nd Ave, approximately 38 km N Maralinga Village, with dense *Acacia aneura, Maireana astrotricha* and *Atriplex vesicaria,* in association with *Acarospora nodulosa* and *Diploschistes thunbergianus.*

Caloplaca sp. Infrequent. This crustose lichen is characterised by orange apothecia which provide a vivid contrast with the underlying substrate. Although *Caloplaca* sp. is common on calcrete pebbles, in association with *Buellia subalbula* (Nyl.)Muell.-Arg., *Peltula omphaliza* (Nyl.)Wetmore, *Verrucaria* sp. and *Diploschistes* sp., it was found on soil overlying rock at only one location which is essentially undisturbed. This species can probably be ascribed to *C. cinnabarina* (Ach.)Zahlbr.

Selected specimen examined:

SOUTH AUSTRALIA: *D.J. Eldridge 3472,* 20.viii.1996, approximately 5 km N of the Forward Gate 12 km N Maralinga Village, on calcrete ridge with Casuarina cristata, Eucalyptus spp., with Psora *crenata, Diploschistes thunbergianus* and *Chondropsis semiviridis.*

Catapyrenium lacinulatum (Ach.)Breuss Common; found within 36 of the 150 quadrats at Maralinga. Although relatively inconspicuous within the crust, it occurred in small colonies of up to 50 squamules. It is distinguished from the closely-related *Catapyrenium squamulosum* (Ach.)Breuss and *C. pilosellum* Breuss by the presence of thick white rhizines and from *Endocarpon* spp. by the eight hyaline spores. *C. lacinulatum* also occurred on sandy substrates but characteristically as isolated squamules.

Selected specimen examined:

SOUTH AUSTRALIA: *D.J. Eldridge 3534*, 25.viii.1996, on calcareous plains of *Casuarina cristata*, *Acacia colletioides* and *Maireana astrotricha* with *Peltula patellata* ssp. *australiensis*, *Desmatodon* convolutus and *Psora crenata*, 1 km S of junction of Left St and Second St, approx 35 km N Maralinga Village.

Catapyrenium pilosellum Breuss Infrequent; occurred in small colonies of up to a centimetre across. Separated from *C. lacinulatum* by the presence of marginal perithecia.

Selected specimen examined:

SOUTH AUSTRALIA: *D.J. Eldridge 3518*, 23.viii.1996, on plains of scattered *Casuarina cristata* and *Acacia aneura* with calcrete overlying sand, with *Catapyrenium squamulosum*, junction of 5th St. and Central Ave., approx 39 km N Maralinga Village.

Catapyrenium squamulosum (Ach.)Breuss Common. Abundant on calcrete soils at Maralinga. Characterised by laminal perithecia on the thallus; erhizinate. Occurred commonly with the closely-related *C. lacinulatum* which has thick whitish rhizines.

Selected specimen examined:

SOUTH AUSTRALIA: *D.J. Eldridge 3482,* 20.viii.1996, 'Roadside', approximately 20 km N Maralinga Village. on open plains with *Alectryon oleifolius* and *Casuarina cristata*, with *Psora crenata*, *Eremastrella crystallifera* and *Peltula* sp.

Chondropsis semiviridis (F. Muell. ex Nyl.)Nyl. Relatively infrequent. Like *Xanthoparmelia convoluta*, this lichen was common at two of the four undisturbed sites. It was characterised by a foliose dichotomously branched thallus which rolls into a ball when dry. Dry specimens up to 20 mm in diameter were found in the area, often attached to vegetation and small stones. This lichen is common over large areas of South Australia (Rogers, 1972). In New South Wales it is relatively uncommon (Eldridge, 1996), and is probably susceptible to clearing and overgrazing.

Selected specimen examined:

SOUTH AUSTRALIA: *D.J. Eldridge 3475*, 20.viii.1996, approximately 5 km N of the Forward Gate 12 km N Maralinga Village, on calcrete ridge with *Casuarina cristata*, *Eucalyptus* spp., with *Psora crenata*, *Diploschistes thunbergianus* and *Caloplaca* sp.

Collema coccophorum Tuck. Abundant. This squamulose to sub-fruticose lichen was the most commonly occurring soil lichen, and was collected in 134 of the 150 quadrats in the survey area. *Collema coccophorum* is a common component of soil crusts on rangeland soils in the southern hemisphere (Filson and Rogers, 1979, Rogers, 1974, Eldridge, 1996) and in North America (Nash *et al.*, 1977) and the Middle East (Galun and Reichert, 1960; *Faurel et al*., 1953). It was also common on sandy soils, often in association with *Synalissa symphorea* and the moss *Bryum eremaeum*. Specimens were commonly fertile, and specimens were often partially buried in the soil.

Selected specimen examined:

SOUTH AUSTRALIA: *D.J. Eldridge 3486*, 20.viii.1996, on calcrete plains of dense *Senna artemesioides* and *Dodonaea* spp., with *Desmatodon convolutus*, *Fulgensia subbracteata*, *Collema coccophorum* and *Bryum eremaeum*, Tufi test site, approximately 32 km N Maralinga Village.

Diploschistes thunbergianus (Ach.)Lumbsch & Vezda Infrequent. Although found within only one quadrat at each of three undisturbed sites, *Diploschistes thunbergianus* was locally abundant in some areas, often occupying about 5% of the ground cover in some quadrats. Specimens occurred in large colonies up to 8 cm across, and were typically fertile with dark-brown to black immersed apothecia. *Diploschistes thunbergianus* is a common soil lichen over large areas of semi-arid pastoral country in NSW, Queensland, Victoria and Western Australia.

Selected specimen examined:

SOUTH AUSTRALIA: *D.J. Eldridge 3539*, 25.viii.1996, calcrete plains at the junction of Boona Radial and 2nd Ave, approximately 38 km N Maralinga Village, with dense *Acacia aneura*, *Maireana astrotricha* and *Atriplex vesicaria*, in association with *Acarospora nodulosa* and *Aspicilia calcarea*.

Endocarpon helmsianum Muell.-Arg. Relatively infrequent. Single squamules were found in six quadrats at four of the 15 sites (Table 1), usually in association with *Endocarpon pusillum*, *Eremastrella crystallifera*, *Fulgensia subbracteata* and *Psora crenata*. This species is separated from other *Endocarpon* spp. by the bisporous asci, the black rhizines and the large (5–20 mm wide) thallus, and from *Catapyrenium* spp. by the number of spores. This species has been recorded in the North-western Botanical region of South Australia (McCarthy, 1991a).

Selected specimen examined:

SOUTH AUSTRALIA: *D.J. Eldridge 3532*, 25.viii.1996, on calcareous plains of *Casuarina cristata*, *Acacia colletioides* and *Maireana astrotricha* with *Peltula patellata* ssp. *australiensis*, *Catapyrenium lacinulatum* and *Psora crenata*, 1 km S of junction of Left St and Second St, approx 35 km N Maralinga Village.

Endocarpon pusillum Hedw. Relatively infrequent. This species is a common component of rangelands soils in Australia (Rogers, 1974; Rogers and Lange, 1972; Eldridge, 1996; McCarthy, 1991a). It is characterised by strongly-developed black rhizines and

distinguished from other *Endocarpon* spp. principally by spore characteristics and thallus size (McCarthy, 1991a).This lichen often occurs in degraded sites and in colonies a few centimetres across, and may be regarded as a pioneer species.

Selected specimen examined:

SOUTH AUSTRALIA: *D.J. Eldridge 3471*, 20.viii.1996, approximately 5 km N of the Forward Gate 12 km N Maralinga Village, on calcrete ridge with *Casuarina cristata, Eucalyptus* spp., with *Psora crenata, Diploschistes thunbergianus* and *Chondropsis semiviridis*.

Endocarpon rogersii P.M. McCarthy Infrequent. This light-coloured species is characterised by bi-septate spores and light coloured rhizines. It is distinguished from *Catapyrenium lacinulatum* by the number of spores. This species is common in areas further to the east (Rogers, 1970; Eldridge, 1996) and has been collected in the North-western and Regions of South Australia (McCarthy, 1991a).

Selected specimen examined:

SOUTH AUSTRALIA: *D.J. Eldridge 3472*, 21.viii.1996, West radial, approximately 1 km from Taranaki ground zero, on limestone plain with scattered *Acacia aneura, Senna artemesioides* and *Maireana sedifolia*.

Eremastrella crystallifera (Taylor)G. Schneider Common. One of the most conspicuous components of the soil crust community at Maralinga. *Eremastrella crystallifera* has an upper thallus structure resembling a mass of pyramidal-shaped crystals. This shape is thought to aid in thermoregulation, and may be useful for channelling water into the thallus. This species was found in 47 of the 150 quadrats, often in large colonies to 5 cm across. This species is relatively uncommon in NSW (Eldridge, 1996), and anecdotal evidence suggests that it increases in abundance with decreasing rainfall.

Selected specimen examined:

SOUTH AUSTRALIA: *D.J. Eldridge 3518*, 23.viii.1996, rocky site approximately 18 km N Maralinga Village, with dense Acacia aneura and *Casuarina cristata*, in association with *Catapyrenium lacinulatum* and *Heppia despreauxii*.

Fulgensia subbracteata (Nyl.)Poelt Common. *Fulgensia* is a very common crustose lichen of calcareous soils is characterised by a distinctive citric-yellow to orange thallus which may become sorediose or granular. Like *Eremastrella crystallifera*, this species appears to be more common as annual rainfall declines. In rangelands in western NSW and western United States (St Clair *et al*,. 1993), it is virtually restricted to soils with a high gypsum (calcium sulphate) content (Eldridge, 1996).

Selected specimen examined:

SOUTH AUSTRALIA: *D.J. Eldridge 3489*, 20.viii.1996, on calcrete plains of dense Senna *artemesioides* and *Dodonaea* spp., with *Desmatodon convolutus, Psora crenata, Collema coccophorum* and *Bryum eremaeum*, Tufi test site, approximately 32 km N Maralinga Village.

Heppia despreauxii (Mont.)Tuck. Abundant; occurring on calcrete and aeolian landscapes in 95 of the 150 quadrats at Maralinga. Thalli are olive-green to grey-green in colour, and generally occurred as small rosettes to 5 mm across (Rogers, 1974). In other disturbed environments, typical squamules have partially segmented lobes, which are often buried in the soil, indicating that active erosion has occurred (Eldridge, 1996). Immature thalli resemble *Peltula patellata* ssp. *australiensis*, from which it cannot reliably be separated except without fertile material. *Heppia* differs from *Peltula* spp. in the presence of 8 non-septate, hyaline spores approximately 15 µm across compared with many (often >100) smaller, hyaline spores in *Peltula* spp.

Selected specimen examined:

SOUTH AUSTRALIA: *D.J. Eldridge 3516*, 23.viii.1996, rocky site approximately 18 km N Maralinga Village, with dense *Acacia aneura* and *Casuarina cristata*, in association with *Catapyrenium lacinulatum* and *Eremastrella crystallifera.*

Lecidea sp. Common. Sterile thalli of *Lecidea* sp. were collected within 40 quadrats at 13 of the 15 sites. These lichens favour consolidated soils, such as along the edges of tracks and on the surface of above-ground cappings of subterranean termite mounds. Most of this material can probably be ascribed to *Lecidea ochroleuca* Pers. which is known to be common on arid zone soils (Rambold, 1989) or *Lecidea terrena* Nyl. which is also facultatively terricolous.

Selected specimen examined:

SOUTH AUSTRALIA: *D.J. Eldridge 3561*, 27.viii.1996, on calcrete plains of dense Senna *artemesioides* and *Dodonaea* spp., with *Desmatodon convolutus, Psora crenata, Collema coccophorum* and *Bryum eremaeum*, Tufi test site, approximately 32 km N Maralinga Village.

Peltula patellata ssp. australiensis (Muell.-Arg.)Büdel Common. This squamulose lichen was widely distributed at Maralinga and collected from 48 of the 150 quadrats at 11 sites. It is characterised by small, circular, greyish squamules upturned at the edges, often with a distinct bluish pruina. Unlike specimens found in western NSW, the squamules from Maralinga were characteristically fertile. *Peltula patellata* ssp. *australiensis* occurred in large colonies up to about 7 cm across, representing a few hundred squamules. It occurred commonly with *Collema coccophorum*, *Heppia despreauxii* and *Catapyrenium squamulosum.*

Selected specimen examined:

SOUTH AUSTRALIA: *D.J. Eldridge 3537*, 25.viii.1996, on calcareous plains of *Casuarina cristata, Acacia colletioides* and *Maireana astrotricha* with *Desmatodon convolutus, Catapyrenium lacinulatum* and *Psora crenata*, 1 km S of junction of Left St and Second St, approx 35 km N Maralinga Village.

Peltula imbricata R. Filson Infrequent. A single sample was collected at one of the undisturbed sites. The species is characterised by the small overlapping squamules (Filson, 1988). has also been recorded from only a few sites in western New South Wales, mostly in areas where grazing has been excluded (Eldridge, 1996).

Selected specimen examined:

SOUTH AUSTRALIA: *D.J. Eldridge 3520*, 25.viii.1996, on calcareous plains of *Casuarina cristata, Maireana astrotricha* and *Atriplex vesicaria*, 3 km E of the junction of 5th and Central, approximately 58 km N Maralinga Village, with *Peltula patellata* ssp. *australiensis, Catapyrenium lacinulatum* and *Psora crenata*; 1 km S of junction of Left St and Second St, approximately 35 km N Maralinga Village.

Psora crenata (Taylor)Reinke Abundant. This squamulose lichen is probably the most conspicuous lichen on the Maralinga soils. It is characterised by large pink to pinkish-white squamules to 5 mm across with deeply crenulate margins. Unlike specimens in eastern Australia (Eldridge, 1996; Rogers, 1972), the black and convex marginal apothecia were rarely observed. *Psora crenata* was more abundant at undisturbed sites. Although widely distributed on calcareous soils, it also occurred on sandy soils dominated by mallee (*Eucalyptus* spp.), particularly in sheltered microsites on the southern and eastern side of *Triodia* spp. hummocks. *Psora crenata* occurred in colonies up to 80 mm across with a median size of 35 mm. An analysis of 50 colonies growing on a sandy soil revealed a strong relationship between the total area occupied by individual colonies, and the number of squamules comprising the colonies (R^2=0.859, $F_{1,49}$=305.66, P<0.001). Other data (Eldridge and Ferris, unpublished) demonstrate that colony size is a good indicator of the number of years since disturbance.

Selected specimen examined:

SOUTH AUSTRALIA: *D.J. Eldridge 3490*, 20.viii.1996, on calcrete plains of dense *Senna artemesioides* and *Dodonaea* spp., with *Desmatodon convolutus*, *Collema coccophorum* and *Bryum eremaeum*, Tufi test site, approximately 32 km N Maralinga Village.

Toninia sedifolia (Scop.)Timdal Relatively infrequent. Found in eight quadrats at only three sites, two of which were undisturbed (Table 1). Characterised by dark-grey, rounded blue squamules, with white to bluish pruina (Filson and Rogers, 1979). Specimens occurred in small colonies up to 5 cm across, often in association with *Psora crenata*, *Eremastrella crystallifera* and *Catapyrenium squamulosum*.

Selected specimen examined:

SOUTH AUSTRALIA: *D.J. Eldridge 3512*, 23.viii.1996, rocky site approximately 18 km N Maralinga Village, with dense *Acacia aneura* and *Casuarina cristata*, in association with *Catapyrenium lacinulatum* and *Heppia despreauxii*.

Xanthoparmelia convoluta (Krempelh.)Hale Infrequent. This foliose lichen was found at only two sites, both undisturbed. Most specimens were vagrants, though a few were loosely attached to rocks and organic material. It is characterised by elongated, convoluted yellowish-green lobes, varying from smooth in small specimens, to cracked in older specimens. It often occurred in association with *Chondropsis semiviridis*, and its absence from all but the undisturbed sites suggests that in this landscape, it is susceptible to disturbance.

Selected specimen examined:

SOUTH AUSTRALIA: *D.J. Eldridge 3476*, 20.viii.1996, approximately 5 km N of the Forward Gate north Maralinga Village, on calcrete ridge with *Casuarina cristata*, *Eucalyptus* spp., *Psora crenata*, *Diploschistes thunbergianus* and *Chondropsis semiviridis*.

Mosses

Acaulon leucochaete Stone Relatively infrequent. Isolated patches of a few plants were found at two sites at Maralinga. Collections of this species are not known from the North-western region of South Australia.

Selected specimen examined:

SOUTH AUSTRALIA: *D.J. Eldridge 3507*, 22.viii.1996, Maralinga Village, on sandy soil under *Callitris glaucophylla* with *Stonea oleaginosa*, *Bryum eremaeum* and *Desmatodon convolutus*.

Bryum eremaeum Catches. ex Spence & Ramsay Common. This moss was the most abundant in terms of individual plants and was commonly associated with soil crust lichens. It was found within 48 of the 150 quadrats, typically in large colonies of more than 50 plants per square centimetre. Species were characterised by stem tubers and a relatively long whitish denticulate hairpoint. This is one of the few Australian mosses which is restricted to arid areas (Spence and Ramsay, 1996).

Selected specimen examined:

SOUTH AUSTRALIA: *D.J. Eldridge 3508*, 22.viii.1996, Maralinga Village, on sandy soil under *Callitris glaucophylla* with *Stonea oleaginosa* and *Desmatodon convolutus*

Crossidium davidai Catches. Relatively infrequent. Small numbers of *C. davidai* occurred at three of the 15 sites, usually as isolated individuals. This moss closely resembles *Desmatodon convolutus*, and specimens possessing more than one cell on the filaments on the adaxial side of the costa were assigned to *C. davidai*. A revision of the

genus *Crossidium* may place these two species into a single complex (G. Bell, pers. comm. 1996).

Selected specimen examined:

SOUTH AUSTRALIA: *D.J. Eldridge 3535*, 25.viii.1996, on calcareous plains of *Casuarina cristata*, *Acacia colletioides* and *Maireana astrotricha* with *Peltula patellata* ssp. *australiensis*, *Catapyrenium lacinulatum* and *Psora crenata*, 1 km S of junction of Left St and Second St, approximately 35 km N Maralinga Village.

Crossidium geheebii (Broth.)Broth. Relatively infrequent. Although common on calcareous soils elsewhere in arid Australia (Eldridge and Tozer, 1996; Downing,1992), *Crossidium geheebii* was found within only 11 quadrats at 7 of the 15 sites, and generally as scattered plants.

Selected specimen examined:

SOUTH AUSTRALIA: *D.J. Eldridge 3545*, 25.viii.1996, on exposed calcrete ridge supporting open *Acacia aneura*, *Stipa* spp. and *Sclerolaena diacantha*, with *Collema coccophorum*, *Stonea oleaginosa* and *Desmatodon convolutus*, Gona Test site, approximately 28 km N Maralinga Village.

Desmatodon convolutus (Brid.)Grout Abundant. Desmatodon convolutus is one of the most common mosses of dry areas (Eldridge and Tozer 1996). At Maralinga it was found in 70 quadrats at 14 of the 15 sites in loose tufts with *Bryum eremaeum* and *Stonea oleaginosa*. Whilst commonly found on calcareous substrates (Downing, 1992; Downing and Selkirk,1993; Howarth, 1983) it also occurs on a range of soil types (Eldridge and Tozer, 1996).

Selected specimen examined:

SOUTH AUSTRALIA: *D.J. Eldridge 3584*, 20.viii.1996, in road drain supporting dense *Senna artemesioides*, Tufi Test site, approximately 28 km N Maralinga Village.

Stonea oleaginosa (Stone)R.H. Zander Common; and found within 36 quadrats at ten of the 15 sites. Outside the study area, specimens occurred on sandy soils associated with mallee vegetation and around Maralinga Village (Table 4). Specimens with gemmae were observed on only a few occasions. This moss is often overlooked in collections as it is often half buried under the soil surface, and the red apices of the leaves closely resemble the iron-rich soils on which it is found. Stone (1978) and Catcheside (1980) report that it is not uncommon on desert soils. It has been recorded from a wide variety of landscapes and soil types in western New South Wales (Eldridge and Tozer, 1996).

Selected specimen examined:

SOUTH AUSTRALIA: *D.J: Eldridge 3535*, 25.viii.1996, on calcareous plains of *Casuarina cristata*, *Acacia colletioides* and *Maireana astrotricha* with *Peltula patellata* ssp. *australiensis*, *Catapyrenium lacinulatum* and *Psora crenata*, 1 km S of junction of Left St and Second St, approx 35 km N Maralinga Village.

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PULTENAEA KRAEHENBUEHLII, A NEW SPECIES ENDEMIC TO THE NORTHERN MOUNT LOFTY RANGES, SOUTH AUSTRALIA

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Abstract

A new rare species of *Pultenaea* is described that has hitherto been included in *P. largiflorens*, and more recently, *P. stricta*. It is confined to a narrow range of habitats on the upper rocky slopes of Tothill Range and one small outlying hill. Despite a strong superficial resemblance to *P. stricta*, the new species is morphologically distinct and many characters distinguishing the two species are tabulated. *Pultenaea kraehenbuehlii* seems most closely related to *Pultenaea stricta* and *P. gunnii* ssp. *tuberculata*.

The first collection of *Pultenaea kraehenbuehlii* was made by Enid Robertson in 1952 from a small hill known locally as Spring Hill, near Black Springs in the northern Mount Lofty Ranges. This site was of interest because it had the (then) only known South Australian population of *Eriostemon verrucosus* A. Rich. (Bendigo Wax-flower), a remarkably disjunct outlier from its main distribution in western Victoria. The *Pultenaea* specimen was incorrectly identified as *P. largiflorens* F. Muell. ex Benth., a species widely distributed in woodlands of southern Australia. Subsequent collections of the *Pultenaea* made by botanists visiting the *Eriostemon* population at this site over the years have remained misidentified in the same way.

In 1963 the new species was inadvertently collected in the nearby Tothill Range but remained unrecognised in a mixed collection with *Pultenaea largiflorens*. Notably this coincided with the discovery of a second *Eriostemon* population, also on Tothill Range (Kraehenbuehl, 1992, p. 352).

The *Pultenaea* was disregarded until a 1973 collection from Tothill Range (A.G. Spooner 3029) was given a field determination as *Pultenaea ? stricta*. As *P. stricta* Sims was otherwise confined to Victoria, Tasmania and the lower Southeast of South Australia, the occurrence was finally recognised as being biogeographically significant. A collection that has been attributed to NSW from the herbarium of R. Tate dated 13.xi.1882 from Lake George most likely refers to Lake George near Beachport in the South-east of South Australia. Henceforth the Tothill Range *Pultenaea* was generally identified as a Northern Lofty outlier of *P. stricta*, the view adopted in the flora treatments of Weber (1986; 1993), although some material continued to be confused with *P. largiflorens*.

Despite the general morphological similarity with *P. stricta*, the possibility of the Tothill Range *Pultenaea* being a distinct species was suggested by the very different habitat (rocky quartzite slopes compared to swampy habitat) and habit (a dense, stiff, often compact and woody shrub compared to an effuse, flexuose and slender shrub). Closer examination revealed that the new species is quite different from *P. stricta* in many morphological characters.

Pultenaea kraehenbuehlii P. Lang, *sp. nov.*

Pultenaeae strictae Sims affinis, a qua differt caulibus cito glabrescentibus; ramulis lateralibus divergentibus late vel patentibus, saepe subspinescentibus; internodii brevioribus (longitudine 2-5 mm a basi ramuli lateralis ad nodum primum ramuli lateralis); facie adaxiali folii impolita, insuper nervo medio plana atque sine sulco; apice folii modo leniter recurvato, obtuso, sine mucrone; lobis stipulae divergentibus; floribus (1)2-4(5) per racemo capitato.

Type: P.J. Lang 2532, 19.ix.1996, south side of Niblet Gap, 33°56'09"S 138°57'03"E, Tothill Range, Northern Lofty Region, South Australia (holo.: AD 99727281; iso.: AK, BRI, CANB, HO, K, MEL, NSW, NY, PERTH, PRE).

Description (Fig. 1)

Dense, intricate, erect; woody *shrub* to 1.5m (rarely 2m) high with stiff, divaricate branches; mainly glabrescent, with sericeous-pubescent indumentum of simple, straight, whitish, basifixed, antrorse, appressed hairs on young shoots, and persisting on pedicels, calyx and ovary. *Branchlets* rapidly glabrescent; recently-hardened young stems glabrate, angular, pale buff to light orange-brown (RHS, 1966: 174A–D) aging red-brown (176 B) with pustulate to irregularly tuberculate ribs confluent with rostriform pulvini on which petioles are inserted; older ribs swollen, rounded and crisped or corrugated; older stems becoming terete with shiny pellicle aging whitish to silver-grey (198 D) and splitting along ribs to form longitudinal vitae; lateral branchlets mostly widely divergent to patent, often subspinescent after abscission of terminal inflorescence and distal leaves. *Leaves* alternate, rather crowded, often reducing markedly in size towards branchlet apices on flowering branches; *petiole* 0.4-0.9 mm long, light brown (165 C), finely rugose, glabrate; *lamina* (2) 4-9 (10.5) mm long x (1.4) 2-3 (3.7) mm wide, narrowly oblong-obovate to oblanceolate (or broadly elliptic-obovate and very small immediately below inflorescence or near apex of terminal shoots), more or less flat to slightly concave above with a gently recurved, obtuse apex; strigose when young, soon glabrate; discolorous, slightly darker dorsally than ventrally, greyish-green (136 B-C); margins on ventral surface slightly thickened and usually weakly pustulate; *midrib* dorsally not evident to obscurely and faintly ridged (in dried material), ventrally inconspicuous, slightly raised, concolorous with lamina except for pale brownish tinge near junction with petiole, and usually lightly pusticulate. *Stipules* 0.5-1 mm long, orange-brown (172 A-D) aging dark red-brown (166 A), fused behind petiole with only upper 1/2 to 1/4 of lobes free; lateral outer faces narrow-triangular, comprising divergent midribs and narrow outer laminae; inner laminae connate, forming a central membrane c. 0.5 mm wide appressed to stem. *Inflorescence* usually terminal, sessile, condensed head-like raceme of (1)2-4(5) flowers and a terminal vestigial pubescent *rhachis* 3-4 mm long bearing 2-3(5) reduced brown floral bracts at summit. *Bracts* 12-17, imbricate, obtuse to obscurely emarginate, chartaceous, glabrate except for small tomentose apical tooth and minutely fimbriate margins, deciduous just before anthesis (except for a few persistent basal, small, dark, stipuliform bracts); inner bracts to 5-6 mm long, ovate to elliptic, (light) orange-brown (172 A-D), outer bracts shorter, broadly ovate, red-brown (166 A). *Flowers* 7.5-9 mm long; *pedicels* 1.8-3 mm long, sericeous; *bracteoles* 2.5-3 (4) mm long x 0.4-0.8 mm wide, (narrowly)-oblanceolate, sparsely strigose to glabrescent, orange-brown (172 B-C), lacking stipules, inserted 1/3 to 1/2 way up from base of calyx tube, stipe-like base of bracteole often adnate to calyx tube for 0.5-0.8 mm proximally; *calyx* (3.5) 4-5 (5.5) mm long, inside surface pinkish-red (47C) and mostly glabrous but puberulent near margins of lobes, outside of tube pubescent to sericeous with lobes sericeous; dorsal lobes broadly triangular; ventral lobes (1.7)2-3 mm long, triangular; *standard* 11.5-14 mm wide x 8-10 mm high with claw 2-3.5 mm long, yellow-orange (16 A), with a yellow (9 B) central patch at base surrounded by a corona of 20-25 red (53A) rays and suffused orange-red (34 A); *wings* 8.5-9.5 mm long x 3-3.5 mm wide with claw 2 mm long; *keel* 6.5-8 mm long x 3.5 mm high, red (53 A) with a small pouch near the base on each lobe, and claws 2-3 mm long; *ovary* sessile, 2-2.5 mm long, sericeous; *style* slender, curved, 6-7.5 mm long. *Pod* 7.4-8.8 mm long x 4.3-4.8 mm wide with a short mucro formed from base of style, compressed ovoid-ellipsoid, with fine raised transverse veins emanating from the thickened margins, glabrous inside, pubescent outside when young, becoming glabrous above but retaining pubescence in proximal 1/4 - 1/3 that is enclosed by calyx. *Seed* 1-2 per pod, (irregularly) ovoid, 2.7-3.6 mm long x 1.9-2.1 mm wide brown (165 A) to black (202 A); *aril* 2-2.3 mm long, pale whitish brown (165 D), divided distally into an irregular mass of fine white lobes. (Fig. 1).

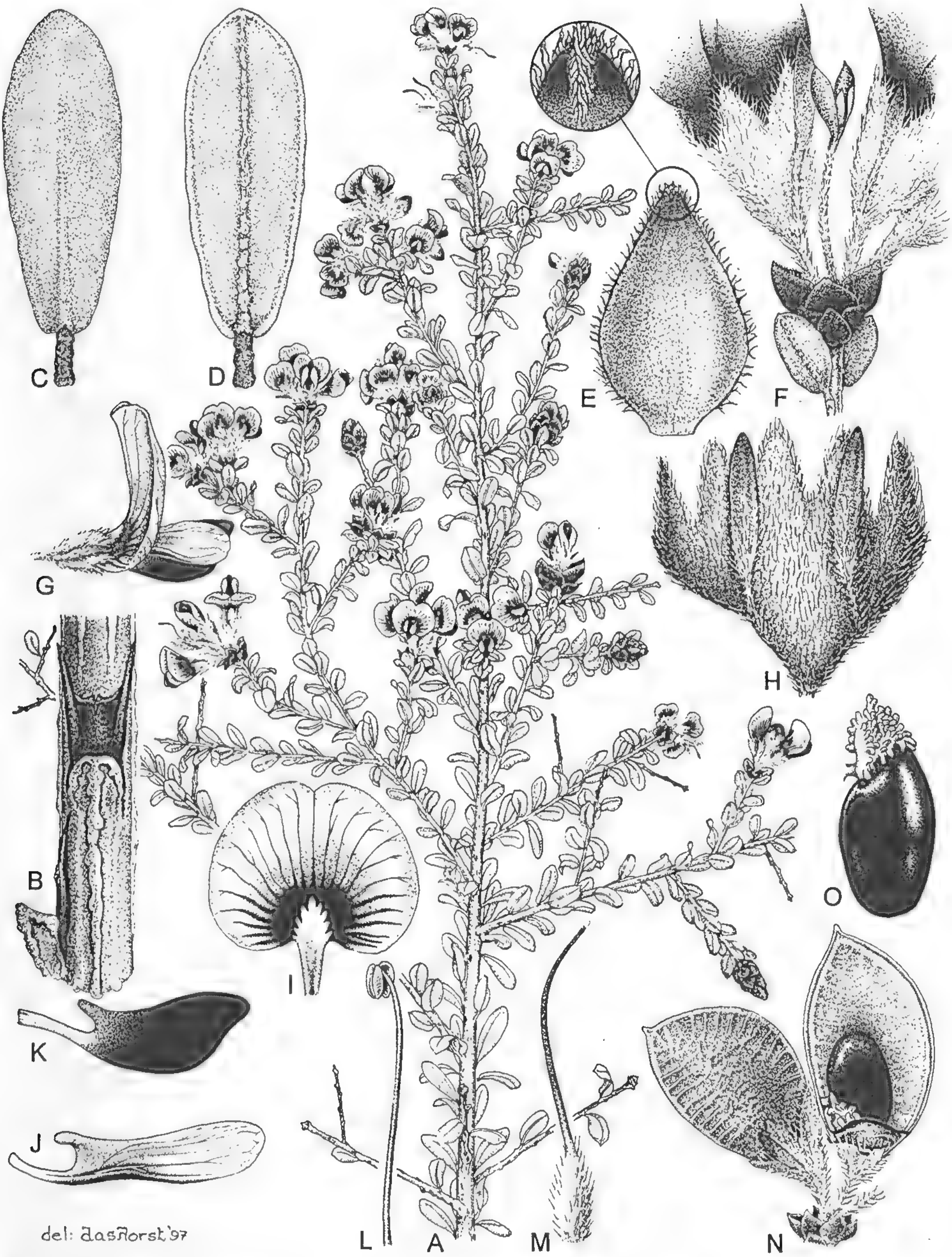

Fig. 1. ***Pultenaea kraehenbuehlii*** P. Lang. **A,** flowering branch with some buds still enclosed by floral bracts ×·8; **B,** young stem with leaves removed, showing stipules and ribs ×15; **C,** leaf from above ×10; **D,** leaf from below ×10; **E,** outer floral bract ×5; **F,** part of inflorescence showing persistent lower bracts and vestigial rachis bearing terminal bracts ×3; **G,** flower in side view ×2·5; **H,** opened out calyx with bracteoles ×10; **I,** standard petal ×4; **J,** wing petal ×4; **K,** keel petal ×4; **L,** stamen ×7; **M,** gynoecium ×7; **N,** pods ×4; **O,** seed ×8. (**A–M,** *P.J. Lang 2532* (isotype); **N & O,** *D.N. Kraehenbuehl 5520*).

Affinities

Pultenaea kraehenbuehlii differs from many species of similar general appearance by its glabrate branchlets and leaves. It belongs with a group of species characterised by: more-or less flat leaves with margins recurved to flat and the upper surface darker than the lower, inflorescences of terminal head-like racemes, floral bracts (when present) entire and deciduous, and pubescent ovaries. Its closest relatives appear to be *Pultenaea stricta*, and *P. gunnii* Benth. (particularly *ssp. tuberculata*), with a more distant relationship to *P. platyphylla* N.A. Wakef.. The first two species are from Victoria and Tasmania (with *P gunnii* ssp. *tuberculata* confined to the Brisbane Ranges in Victoria) and the last from Victoria and southern New South Wales. This fits the pattern of a number of other species in the Northern Lofty region displaying biogeographical links with Eastern Australia.

Pultenaea largiflorens is similar to the new species in growth form and stature, leaf size, floral morphology and flowering time. It sometimes occurs sympatrically and not surprisingly has often been confused with *P. kraehenbuehlii*. However, it appears not closely related and can be readily distinguished from the new species by its: conduplicate leaves often clustered in groups of three; green, terete young stems; caducous floral bracts (falling well before flowering); axillary inflorescences; and more persistent indumentum on stems and underside of leaves. A previously unreported character in *P. largiflorens* is the presence of sub-basifixed unequally bifid hairs, distinct from the basifixed (but still ventrally attached) hairs in *P. kraehenbuehlii* (Fig. 2). Similar sub-basifixed hairs have also been observed in broad-leaved forms of *P. laxiflora* Benth.. These differences in hair types are subtle and easily overlooked but they may prove helpful in clarifying relationships within the genus.

Pultenaea kraehenbuehlii most closely resembles *P. stricta*, although there are many morphological differences between the two species which are summarised in Table 1. Useful diagnostic characters distinguishing *P. kraehenbuehlii* include its obtuse leaf apex (mucronate in *P. stricta*), absence of a furrow or crease above the midrib, divergent stipule lobes, and fewer-flowered inflorescences. It is also distinguished by more closely spaced leaves, and a series of measurements of the distance to the first leaf on lateral branchlets displayed virtually no overlap between the two species. A somewhat unreliable character is the marked reduction in fully expanded leaf size towards branchlet apices, particularly on flowering branches. This feature, while very obvious on some specimens of *P. kraehenbuehlii*, is not apparent on many others. It has also been observed once in *P. stricta* and occurs in *P. gunnii*. It may be related to growth that is put on rapidly late in the season and its significance requires further investigation.

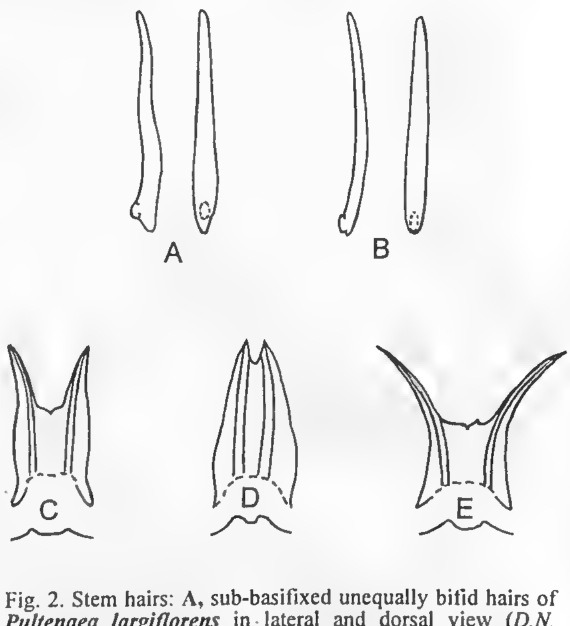

Fig. 2. Stem hairs: **A**, sub-basifixed unequally bifid hairs of ***Pultenaea largiflorens*** in lateral and dorsal view (*D.N. Kraehenbuehl 5407*); **B**, basifixed hairs of ***P. kraehenbuehlii*** in lateral and dorsal view (*P.J. Lang 2535*). Stipules: **C**, ***P. kraehenbuehlii*** (*P.J. Lang 2532* (isotype)); **D**, ***P. stricta*** (*R.M. Welbourne 230*); **E**, ***P. gunnii*** ssp. ***tuberculata*** (*M.G. Corrick 10787*).

Pultenaea gunnii approaches the new species in having: flattish, generally non-mucronate leaves, and stipules with divergent lobes (Fig. 2), but overall it seems to be more different than *P. stricta.* Most significantly *P. gunnii* lacks properly developed floral bracts, having only small stipuliform bracts which (according to Corrick, 1977) enclose the buds only when very young. It also differs in its much smaller bracteoles, its stipule lobes being free for the greater part of their length, and its indumentum of loosely appressed or curved hairs that are sometimes golden or brownish-coloured particularly on the calyx. In ssp. *gunnii* the leaves differ in their ovate/lanceolate shape and their undersurface which is hairy and has distinctly recurved margins, although they agree in the obscure midrib. The resemblance to *P. kraehenbuehlii* is greater in ssp. *tuberculata* Corrick which has leaves with their maximum width near the centre and their margins thickened and not recurved, although the midrib differs in being prominently thickened (Corrick, 1993b, 1996). The presence of tubercles or pustules on the upper leaf surface and leaf margins below suggests a possible relationship with *P. kraehenbuehlii* which has pustulate to tuberculate ribs on the stem and is often lightly pustulate on leaf margins.

Pultenaea platyphylla also displays some similarities to the new species, most notably in its flattish, obtuse, non-mucronate, glabrate leaves and its angular stems developing swollen ribs which persist as silvery vitae on older branchlets. However, it differs substantially by: the more persistent stem indumentum; the markedly discolorous leaf surfaces; the emarginate leaf apex and prominently thickened midrib; the lack of pustules or tubercles; the stipules with parallel to convergent lobes; and the inflorescence of more than five flowers.

	P. stricta	*P. kraehenbuehlii*
Habit	• effuse, slender shrub with major axes largely unbranched	• dense, intricate shrub with major axes divaricate
	• major branches often weak/flexuose	• major branches always stiff and woody
Lateral branches	• mostly inclined to axes	• mostly widely divergent to patent
	• never subspinescent	• often subspinescent following abscission of terminal inflorescence and leaves
Stems	• persistently sericeous to sparsely pubescent or glabrescent	• glabrate
	• ribs smooth to weakly pustulate, remaining angular	• ribs pustulate to irregularly tuberculate, becoming swollen, rounded and crisped or corrugated
Leaves	• widely spaced, 5–30 mm to first node on lateral branches	• crowded, 2–5 mm to first node on lateral branchlets
	• more or less uniform in size when fully expanded	• often reducing in size markedly towards apices of branchlets
	• conspicuously discolorous	• obscurely discolorous
	• upper surface shiny	• upper surface matt
	• apex abruptly recurved, mucronate	• apex gently recurved, obtuse
	• midrib marked by furrow on upper surface	• midrib obscurely raised or not evident above
	• lower midrib prominent, distinctly raised	• lower midrib inconspicuous, barely raised
	• petioles pubescent or sparsely puberulent, rarely glabrous	• petioles glabrate
Stipules	• lateral lobes parallel to slightly convergent, fused median section narrower than base of lobes	• lateral lobes divergent, fused median segment wider than base of lobes
Inflorescence	• (3) 4–6 (9) -flowered	• (1) 2–4 (5) -flowered
	• floral bracts 15–22	• floral bracts 12–17
Calyx	• lobes villous	• lobes sericeous
Pods	• strigose	• glabrescent

Table 1: Comparison of ***Pultenaea stricta*** and ***P. kraehenbuehlii***.

Distribution (Fig. 3)

Endemic to the Northern Lofty region of South Australia and confined to the Tothill Range and nearby Spring Hill. The distribution is contained within an area 22 km by 6 km.

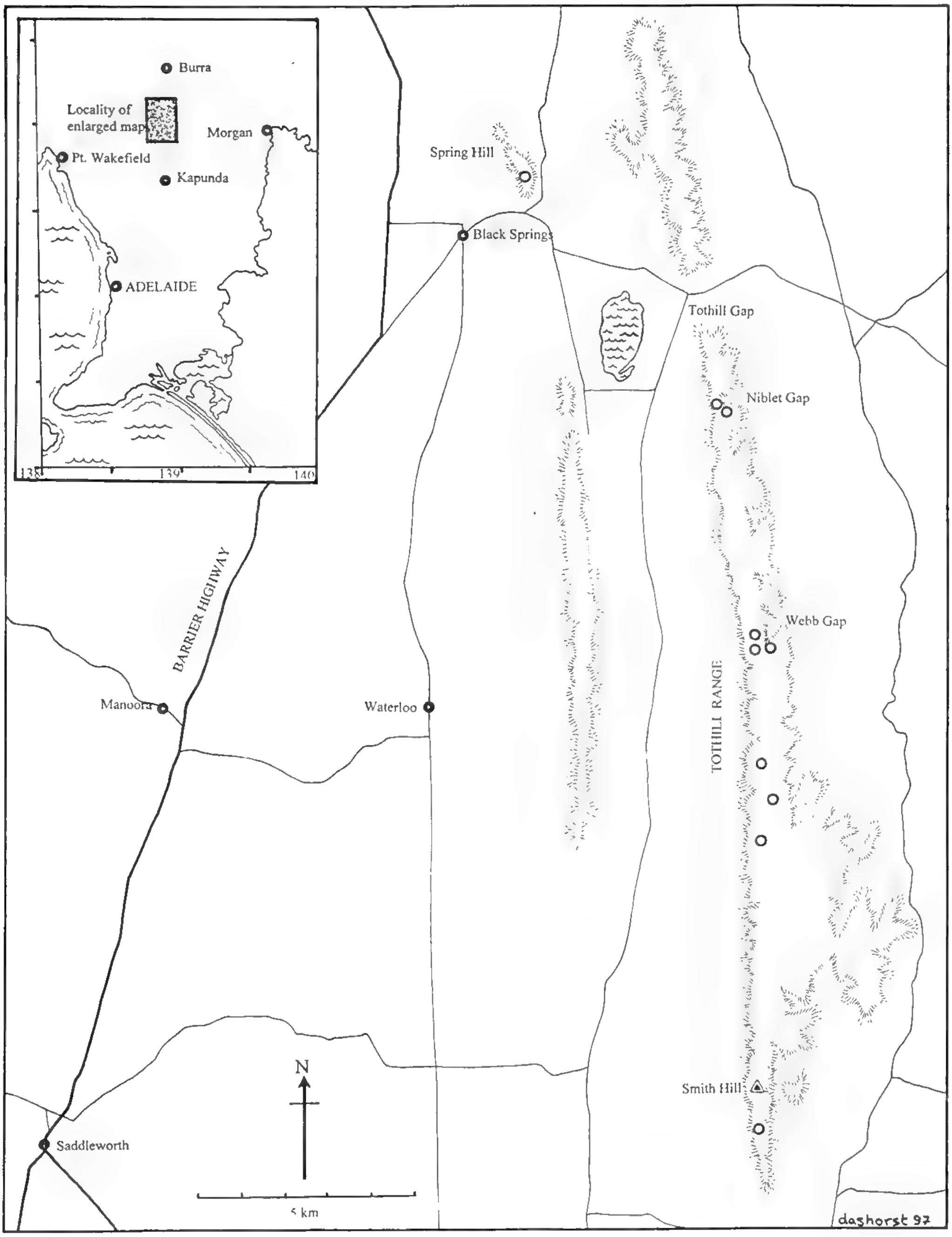

Fig. 3. Distribution of ***Pultenaea kraehenbuehlii*** (O).

Ecology

Pultenaea kraehenbuehlii is restricted to the upper rocky slopes of hills and ranges composed of Gilbert Range quartzite (Forbes, 1964) within an altitudinal range of 540-650 m. Soil sampled at the type locality amongst rocky outcrops was a skeletal dark grey (Munsell: 10YR 2.5/1; 3/1.5 dry) sandy loam of pH 5.25; at another less rocky site it was a dark greyish-brown (10YR 3.5/2; 6/2 dry) sandy clay-loam of pH 4.75.

The plant community comprises a Low open woodland usually with *Allocasuarina verticillata* (Drooping sheoak) and other species such as *Eucalyptus odorata* (Peppermint box), *Callitris preissii* (Native pine), *Exocarpos cupressiformis* (Native cherry) and in wetter sites, *Eucalyptus goniocalyx* (Long-leaf box). The understorey usually supports a mid-dense to scattered shrub layer with a selection of the following major species: *Spyridium parvifolium, Xanthorrhoea quadrangulata, Hakea carinata, Correa glabra, Allocasuarina muelleriana* and *Eriostemon verrucosus*. The ground cover is typically dominated by *Gonocarpus elatus, Cheilanthes austrotenuifolia* and various herbs.

In several instances *Pultenaea largiflorens* has been observed growing side-by-side with *P. kraehenbuehlii.* Very similar flower colouring and floral morphology, together with coincident flowering times suggests that both species employ the same pollination strategy. Despite this, they must be effectively reproductively isolated as no intermediates have ever been detected between them. This is consistent with the fact that they do not appear to be closely related on morphological grounds. *Pultenaea laxiflora* also occurs on the upper slopes of Tothill Range although uncommon, and again there is no evidence of it intergrading with *P. kraehenbuehlii.*

Closely browsed bushes of *P. kraehenbuehlii* occur both within, and outside of, stock-proof fences and indicate that it is palatable to euros as well as sheep. Macropod browsing has been reported for *P. victoriensis* Corrick by Corrick (1993a).

Conservation status

The population on Spring Hill is regarded as vulnerable because continued grazing by stock presents a long-term threat to seedling recruitment. The main population on Tothill Range is considered to be adequately reserved being well represented in Heritage Agreements areas (HA655, HA669 and HA927). Conservation status for the species is assessed as Rare (and not threatened) at national, State and region levels and the code 2RCa is proposed following the system of Briggs and Leigh (1996).

Etymology

Named after my colleague Darrell N. Kraehenbuehl, an esteemed South Australian botanist, naturalist and historian who has had a long-standing interest in he flora of the Tothill Range, and in recognition of his contribution to botanical endeavour in this State. Darrell directed my attention to this species and was the first to collect it from the Tothill Range.

Selected specimens of *Pultenaea kraehenbuehlii* (30 seen at AD):

SOUTH AUSTRALIA. NORTHERN LOFTY: *E.L. Robertson s.n.*, 29.v.1952, Black Springs.; *D.E. Symon s.n.*, 28.xii.1952 Black Springs; *G.E. Gardiner s.n.*, 2.ix.1962, Black Springs; *A.G. Spooner 1577*, 12.ix.71 Black Springs; *D.N. Kraehenbuehl 1176(B)*, 27.x.1963, Tothill Range, 1 km S of Smith Hill; *A.G. Spooner 4235*, 5.x.1975, Niblet Gap, Tothill Range; *D.J. Pfitzner 4*, 22.viii.1982, Tothill Ranges, 33°55'30"S, 138°57'30" [= Niblet Gap]; *P.J. Lang 1918*, 13.ix.1991, 5.6 km N of Smith Hill, central Tothill Range, north-facing gully behind western escarpment of Range, Section 349, Hundred of Waterloo (CANB); *P.J. Lang 1952*, 13.ix.1991, 0.5 km SE of Webb Gap, Tothill Range; *D.N. Kraehenbuehl 5520*, 7.xii.1992, Western foothills of Niblet Gap, northern Tothill Range (CANB, PERTH); *P.J. Lang 2545*, 19.ix.1996, 3.1 km S of Webb Gap, Section 352 Hundred of Waterloo, Heritage Agreement No. 655, Tothill Range, 34°00'26"S, 138°57'37"E (MEL).

Selected specimens of *Pultenaea stricta* (42 seen at AD):

SOUTH AUSTRALIA. SOUTH-EASTERN: *R.M. Welbourn 230 & D. Klein*, 20.x.1964, Overland Track 3 mi [c. 5km] S of Mt. Burr; *R.M. Welbourn 218*, 24.x.1964, Glencoe-Wandilo Road (CANB); *I.B. Wilson 889*, 12.x.1968, Marsh's Swamp; *N.N. Donner 9480*, 21.x.1982, Honan's Scrub Native Reserve, Mt. Gambier Forest (TRN, W, WSL); *R. Bates s.n.*, xi.1986, Piccaninnie Ponds.

VICTORIA: *P.S. Short 3208* et al., 26.ix.1988, c. 5 km east of Casterton-Dartmoor Road, along Moonlight Road (CANB, MEL); *I.C. Clarke 2111*, 30.xi.1992, Otway Plain, c. 7 km S of Purrumbete South on Jancourt Forest Road, 38°24'40"S, 143°12'47"E (A, BRI, CANB, MEL, S).

TASMANIA: *A. Moscal 2942*, 29.ix.1983, Lyme Regis (Lagoon Flat) (HO).

Acknowledgments

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J. Adelaide Bot. Gard. 18(1): 33–41 (1998)

SIDA SECTION *SIDA* IN AUSTRALIA: A REVISED KEY, A NEWLY INTRODUCED SPECIES, *S. SUBCORDATA* SPAN., AND NAME CHANGES FOR *S. ROHLENAE* VAR. *MUTICA* (BENTH.)FRYXELL AND *S. MAGNIFICA* DOMIN

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Abstract

A revised key is provided to the species of *Sida* section *Sida* of Australia. *Sida subcordata* Span., a Malesian species, is recorded for the first time from Western Australia and the Northern Territory. The species previously referred to *S. parvifolia* DC. is now referred to the earlier named *S. pusilla* Cav. and specimens assigned to *S. rohlenae* Domin var. *mutica* (Domin)Fryxell are newly named as *S. rohlenae* Domin ssp. *occidentalis* R.M. Barker, while *S. magnifica* Domin is reduced to a subspecies of *S. atherophora* Domin.

Introduction

The species of *Sida* section *Sida* were last treated in a conspectus by Fryxell in 1987. While the changes in that time are not great, except in the extensions of distribution compared with those depicted by Fryxell, in view of the economic importance of this group of plants as weeds for which biological controls are being sought in northern tropical Australia (Forno 1992) and the probable introduction of yet another species with weed potential, it is useful to bring the taxonomy up to date. Full treatments of each species will appear in the forthcoming revision of *Sida* for Australia.

According to Fryxell, whose work has been predominantly on American species of *Sida*, but with a considerable field knowlede of Australian *Sida* species, only those species which belong with *Sida* sect. *Sida* should be treated as true *Sida*. These species are characterised by calyces which are distinctly 10-ribbed at the base and by mericarps in which the upper dehiscent portion is separated from the lower indehiscent portion by a distinct "shoulder" (Fryxell 1985). The upper portion of the mericarp is often extended into a pair of spines.

Fryxell would treat the rest of the Australian species as *Sidastrum* (Fryxell 1987,1988). Initial cladograms by the author, based on morphological characters, support section *Sida* as a uniquely derived group from the unresolved mass of Australian *Sida* species, but the lack of resolution within the rest of the Australian species makes it difficult to determine just where and how the native species should be treated. American species of 4–5 genera which have been segregated from S*ida*, when added to the cladistic analysis of the Australian species also fall within the unresolved mass. There remains a great deal of work to be done in this area but further discussion of this issue will be incorporated in the revision of the Australian species.

Key to species of *Sida* sect. *Sida* in Australia

1 Mericarps with retrorsely barbed apical spines

2 Leaves ovate to broadly ovate; flowers initially solitary but becoming crowded apically with maturity

3 Plant obviously densely pubescent; petals 7–8 mm long, 6.5 mm wide at widest part, +/– truncate; mericarps 10–11 [northern and coastal Qld, northern NT, Kimberleys in WA, occasional in southern areas e.g. Cadney Park in SA] .... ***Sida cordifolia***

3: Plant not obviously pubescent although tiny stellate hairs are present; petals c. 12–15 mm long, c. 13 mm wide at widest part, decidely asymmetrical; mericarps 7–8 [sparingly collected ?introduction from monsoon or vine thickets of Kimberleys and Darwin region] .... ***Sida subcordata***

2: Leaves narrowly ovate to elliptic; flowers solitary

4 Plants with raised stellate pubescence; mericarps 6–8, glabrous [Hughenden–Moura–Charleville, Qld] .... ***Sida atherophora*** **ssp.** ***atherophora***

4: Plants with velvety appressed pubescence, sometimes mixed with longer simple hairs; mericarps 10, pubescent [central to northern Australia]........ ***Sida rohlenae*** **ssp.** ***rohlenae***

1: Mericarps with or without apical spines, if present not retrorsely barbed

5 Mericarps 7–11; pedicel more than 7mm long

6 Stems with long simple hairs over a close velvety indumentum; mericarps 10–11, glabrous; [modern collections from Kimberleys, Daly Waters area] .... ***Sida rohlenae*** **ssp.** ***occidentalis***

6: Stems lacking long simple hairs; mericarps pubescent at least at apex

7 Stems with raised indumentum of stalked stellate hairs; leaves serrate for almost entire length; mericarps 7–9, stellate-hairy apically, lacking apical spines; petals 8–12 mm long [Walsh Ra.–Magnetic Is., Qld] .... ***Sida atherophora*** **ssp.** ***magnifica***

7: Stems with smooth indumentum of minute sessile stellate hairs; leaves serrate apically, entire basally; mericarps 9–11, puberulent, with 2 apical spines; petals c. 6 mm long [weedy sp. capable of persisting in cooler areas, NSW,QLD,WA,NT] .... ***Sida rhombifolia***

5: Mericarps 5–7; pedicel less than 7 mm long

8 Plant prostrate in coastal sands; mericarps puberulent [NT and Kimberley coast] .... ***Sida pusilla***

8: Plants erect, non coastal; mericarps glabrous or pubescent

9 Plants quickly glabrescent; mericarps 5–7, glabrous [weedy sp., tropical Australia] .... ***Sida acuta***

9: Plants pubescent; mericarps 5, pubescent [weedy sp., northern Australia] .... ***Sida spinosa***

1. Name change for *Sida parvifolia* DC.

Sida parvifolia DC. was first recognised for Australia by Fryxell in 1987 despite the fact that it was probably amongst the plants collected by Robert Brown in 1801; Brown referred to it in his unpublished manuscript as "S. gracilis". However, since it has been discovered that there is an earlier Cavanille name available, the species is now to be referred to as *S. pusilla* Cav. (Craven & Fryxell 1993, Fuertes & Fryxell 1993, DuPuy 1993).

Sida pusilla Cav., *Diss.* 1: 6, t. 1. f. 4 (1785).

Holotype: MA-CAV 476275 n.v., fide Fuertes & Fryxell (1993).

Sida parvifolia DC., *Prodr.* 1: 461 (1824); Fryxell, *Sida* 12: 22–27 (1987); Hnatiuk, *Census Austral. Vasc. Pl.* 309 (1990).

Holotype: *Bory s.n,* s.dat., Rèunion "in insula Borbonia" [Indian Ocean] (G–DC, fiche AD).

Distribution

Beaches of northern coastal Australia in Northern Territory and Western Australia, the beaches often associated with coral reefs. Many additional collections from the Northern Territory in DNA, seen on a recent visit to Darwin, have not been cited here. Occurs elsewhere in the Mascarene (Seychelles, Réunion) and Lesser Sunda (Sumba and Timor) Islands.

Specimens examined:

WESTERN AUSTRALIA: *A.A. Mitchell 2976*, 29.iii.1993, between beach and lighthouse, Lesueur Island (PERTH).

NORTHERN TERRITORY: *R.M. Barker 804*, 25.v.1994, Black Point Ranger Stn, Cobourg National Park (AD,dupl.); *R. Brown s.n.*, 24.ii.1803, Inglis Island (island z), (CANB, NSW194528, MEL112057); *N. Byrnes 1100 & J. Maconochie,* 4.x.1968, Black Point(NT, AD); *G. Chippendale 8259*, 22.vii.1961, 3½ mls SW Danger Point, Cobourg Pen. (NT); *P.A. Fryxell & J. McD.Stewart 4877*, 22.vi.1985, 3km NE of Point Blaze(CANB); *P.A. Fryxell et al. 4922*, 25.vi.1985, Cobourg Peninsula, Port Essington on eastern shore at Turtle Point(CANB); *P.A. Fryxell et al. 4927*, 26.vi.1985, Cobourg Peninsula, Table Head on E shore of Port Essington(CANB); *T.S. Henshall 823*, 23.x.1974, Peron Island(NT); *J.R. Maconochie 2076*, 2.vii.1975, Elcho Island (DNA,NT,CANB).

2. *Sida subcordata* Span., another recent introduction to Australia?

A few recent collections of *Sida* from the Kimberleys and Darwin area differed sufficiently from the rest of the *Sida* specimens seen to warrant further investigation. They proved to be *S. subcordata* Span., a Malesian species for which material had been borrowed from Leiden for comparative purposes since it, along with *S. cordifolia* L., is reputed to be an Old World endemic.

Sida subcordata Span., *Linnaea*, 15: 172 (1841).
Type citation: "Ins. Timor"

Isotypes: *Anon. s.n.,* s.dat., Without locality [but according to Borssum Waalkes (1966) *Spanoghe s.n.,* s.dat., Timor (L908.140–635, L908.140–609).

For a description and long list of synonyms of this species in Malesia see Borssum Waalkes (1966).

Distribution

At this stage only known from coastal Kimberley localities in Western Australia and from Mt Bundey near Darwin in the Northern Territory.

Ecology

Found in vine or monsoon thicket. Flowering specimens have been collected in March and April, with the May specimen only having mature fruits present.

Typification

Borssum Waalkes (1966) listed 3 isotypes for this species, L 908.140–642, L 908.140–635 and L 908.140–639. The latter two collections (with type labels) were included in the loan from L although the last specimen bears the number 609 rather than 639. Neither of the specimens seen bears any collector or locality details and the basis for their designation as types is not clear; it can only be presumed they were correctly selected.

Notes

1. *Sida subcordata* Span. has presumably been introduced to the northern areas of Australia relatively recently. As this species shares all of the characteristics which make *S. acuta* Burm.f., *S. rhombifolia* L. and *S. cordifolia* L. such successful weeds, it too could become a problem. Its closest relationships are with *Sida cordifolia* L. and like that species, it is apparently an Old World endemic.
2. The relationships of *S. rohlenae* Domin, *S. atherophora* Domin, *S. cordifolia* L. and *S. subcordata* Span. need to be addressed more closely with a study across their range of distribution. Differences between them relate mainly to indumentum and leaf and flower size. They all (with the exception of *S. rohlenae* ssp. *occidentalis and S. atherophora* ssp. *magnifica*) possess the long erect awns with retrorse hairs and all have distinctive 3–4–tubular–armed sessile stellate hairs on the staminal column, the latter characteristic not seen in any other *Sida* species in Australia. It seems likely that this whole group is of Old World origin, in contrast to the probable New World origin of the now pantropical weeds, *S. acuta* Burm.f., *S. rhombifolia* L. and *S. spinosa* L.

Specimens examined:

WESTERN AUSTRALIA: *G.J. Keighery 10707*, 5.iii.1989, Cape Bougainville; 10 km W of Separation Point (PERTH); *A.A. Mitchell & T. Willing 2378*, 8.iv.1992, northern side of Rothsay Water (AD, BROOME, PERTH).

AUSTRALIA. NORTHERN TERRITORY: *R. Fensham 552*, 16.v.1987, Mt Bundey East (DNA).

CHINA::*C.I. Lei 167*, 23.x.1932, Pal Shik Ling and vicinity, Ku Tung village, Ching Mai District (L).

MALESIA. INDONESIA: *Anon. s.n.*, s.dat., Java (L908.140–327); *Kornassi (Exp. Rutten.) 1283*, 12.v.1918, Eiland Boano by Seran (L); *O. Jaag 79*, 28.iv.1938, On slope above Timor–Dilly, Timor (L); *P.E. Schmutz 1310*, 6.iii.1967, West–Flores, Tjereng–Look, 500 m bis Kuste (L).

3. A new name for *S. rohlenae* Domin var. *mutica* (Benth.)Fryxell

When the type of *S. cordifolia* var. *mutica* Benth., the basionym for *S. rohlenae* var. *mutica* (Benth.)Fryxell, was examined, it was was found to agree much more closely with *S. atherophora* ssp. *magnifica* (q.v.) and to differ from Western Australian specimens which had been assigned this name. Consequently a new name for the Western Australian specimens segregated under this name is required. Since these specimens agree with *S. rohlenae* Domin in all characteristics except for the lack of development of awns at the apex of the mericarp (hence "mutica") they have been maintained as an infraspecific taxon of *S. rohlenae*, but raised to subspecific level.

Occasional specimens e.g. *Wright 45*, have only very poorly developed awns. In this particular case the awns do have a few retrorse hairs upon them, and so the specimen has been treated as ssp. *rohlenae* (q.v.) rather than as ssp. *occidentalis*. Such specimens are the reason for not separating the taxa at specific level.

Key to subspecies of *Sida rohlenae* Domin

Mericarps with long retrorsely barbed awns; stems with or without longer simple hairs [widespread across northern Australia] .... ssp. ***rohlenae***

Mericarps with rounded apex, lacking any awns; stems always with longer simple hairs [Kimberley region and/to Daly Waters] .... ssp. ***occidentalis***

Sida rohlenae Domin *ssp.* ***rohlenae***

S. rohlenae ssp. *rohlenae* has two forms, one with the hair covering on all parts a short stellate, more or less appressed tomentum with a velvety appearance, the other with a similar indumentum but mixed with long simple hairs. The presence of these longer hairs seems to be clinal with the greater density of them occurring in populations from more northerly localities while they are usually completely absent from central Australian populations.

Specimen with poorly developed awns cited above: *Wright 45,* 31.v.1987, Daly Waters Access Rd, Northern Territory (BRI).

Sida rohlenae ssp. ***occidentalis*** R.M. Barker, ssp. nov.

Subspecies nova Sida *rohlenae* sed differt a subsp. *rohlenae* muticis apicibus mericarpiorum.

Holotype: *P.A. Fryxell, L.A. Craven & J. McD.Stewart 4551,* 29.v.1985, Western Australia, road to Beagle Bay N of Broome, 10–15 km N of Junction with Broome–Derby Hwy (AD); isotypes: CANB,NY (pf).

Sida rohlenae var. *mutica* auct. non (Benth.)Fryxell: Fryxell, *Sida* 12: 26 (1987)p.p. (at least with respect to Western Australian material); Hnatiuk, *Census Austral. Vasc. Pl.* 309 (1990) p.p.; Wheeler, *Fl. Kimberley Region* 229 (1992).

Upright *subshrub*, 50(–100) cm tall, usually narrower than high, rarely to 120 cm wide, branches erect or ascending with moderately dense long simple hairs above dense velvety layer of minute, sessile stellate hairs. *Corolla* bright yellow-orange throughout, 15–18 mm diameter; petals obovate, 8–9 mm long, 2.2–3 mm wide at claw, 8–9 mm wide at widest part, emarginate apically with tiny ?glandular hairs lining emarginate part, ciliate on claw. *Stamens* c. 50–60. *Styles* 9–10. *Schizocarp* depressed ovoid or transversely elliptic, 4–7.5

mm diameter, glabrous, hardly grooved between mericarps. *Mericarps* 10–11, 2.5–3.2 mm high, shallowly to deeply grooved apically, splitting in 2 at apex.

Distribution

Kimberley region of Western Australia, with two isolated occurrences in the Daly Waters/Larrimah area of the Northern Territory. Its occurrence in the area between these localities is unknown.

Ecology

Weed of disturbed ground, often in sandy areas, but also recorded from clay flats. Flowering March to May, rarely as late as August.

Etymology

Occidentalis is the Latin word for western, referring in this case to the occurrence of this taxon at the western end of the species range.

Notes

Specimens of this taxon from the Kimberleys in the MEL Herbarium were identified as *S. magnifica* Domin which has here been reduced to a subspecies of *S. atherophora* Domin. This identification highlights the closeness of *S. rohlenae* Domin and *S. atherophora* Domin and it may be that these too might be more appropriately treated as the one species.

Specimens examined:

AUSTRALIA. WESTERN AUSTRALIA: *A.C. Beauglehole 52305*, 6.vi.1976, c. 5 km E of Gibb River Kalumburu Mission Rd, between Donkey Creek and Gibb River Aboriginal Paintings area (NT,PERTH); *A.C. Beauglehole 52728*, 13.vi.1976, Mella – Oobagooma Rd, 80 km by road N of Gibb River Rd (PERTH); *A.C. Beauglehole 53101*, 17.vi.1976, Geegully Creek, c. 10 km NNE of junction of Mowla Bluff – Manguel Creek – Nerrima Roads (NT); *A.C. Beauglehole 59201 & E.G. Errey 2901*, 1.ix.1978, 67 km NE of Lagrange Aboriginal Mission turn–off, Great Northern Hwy (NT); *G.W. Carr 4378 & A.C. Beauglehole 48156*, 31.vii.1974, Beagle Bay Rd, 1.5 km N of Great Northern Hwy (NT); *A.J. Ewart s.n.*,iv.1927, Derby (MEL53817); *W.V. Fitzgerald 1585*, viii.1906, nr Erskine Range, W Kimberley (PERTH); *Forrest & Carey s.n.*, 1879, between De Grey River and Lagrange Bay (MEL111654, MEL111655); *T.R. Foulkes 3*, 29.iii.1987, Lot 976 Gregory St., Broome (PERTH); *T.R. Foulkes 5*, 5.iv.1987, Lot 70, Broome (PERTH); *P.A. Fryxell 3859*, 28.iv.1983, c. 42 km N of Broome on road to Beagle Bay (33 km N of junction). (CANB); *P.A. Fryxell & L.A. Craven 3935*, 3.v.1983, Kimberley Downs Station, 100km E of Derby and Gibb River Road (CANB); *P.A. Fryxell & L.A. Craven 3979*, 7.v.1983, 30 km N of Gibb River H.S. at North Creek crossing (CANB); *C.A. Gardner 9552*, 27.vi.1950, Derby (PERTH); *C.A. Gardner s.n.*, 16.v.1951, Gogo (PERTH); *K.F. Kenneally 9823*, 12.iii.1987, Cnr of Port Drive and Guy St, Broome (PERTH); *E. Langfield 100*, 31.viii.1949, Kimberley Research Station (MEL,CANB); *J. Maconochie 1178*, 24.v.1971, 58 miles N of Broome along road to Beagle Bay (MEL,NT); *W.J.O'Donnell s.n.*, ?1887, Near Cambridge Gulf (MEL111785); *D.W. Rust 86*, 7.iii.1950, Karungie, Kimberley Research Station (CANB); *D.W. Rust 158*, 11.iii.1950, Karungie, Kimberley (CANB); *J. Tepper 100*, ii.?1890, Roebuck Bay (MEL); *J.G. Tracey 13864*, 20.v.1981, Between Broome and Jetty Wharf (BRI); *A.S. Weston 12124*, 28.iv.1980, Smoke Creek, SW of Lake Argyle (PERTH).

NORTHERN TERRITORY: *P.A.Fryxell, L.A.Craven & Stewart 4428*, c. 2 miles S of Larrimah (AD,CANB, NY, pf); *T. Wright 45*, 31.v.1987, Daly Water Access Rd (BRI).

4. Reduction of *Sida magnifica* Domin to a subspecies of *S. atherophora* Domin

Sida magnifica Domin was found to be untenable at the species level because it differs from *S. atherophora* Domin predominantly by its muticous mericarps, mirroring the situation found in *S. rohlenae* Domin and its two subspecies described above. In fact, *S. rohlenae* Domin and *S. atherophora* Domin themselves are distinguished primarily on indumentum type and it may be that in the future they would be better treated as the one species.

Sida atherophora Domin, *Biblioth. Bot.* 89: 391 (1928) p.p.; Hnatiuk, *Census Austral. Vasc. Pl.* 309 (1990).

Lectotype here designated: K. Domin 6545, March 1910, near Jericho [Queensland] (PR) isolectotype: (PR). Syntypes: *K. Domin 6542*, March 1910, Jericho (PR); *K. Domin 6543*, March 1910, Jericho (PR 2 sheets); *Bynoe (Domin 6547),* s.dat., between Camooweal and Burketown [Queensland] (PR). Excluding specimens also collected from Jericho by Domin and labelled by him as *S. atherophora* but belonging to *S. rohlenae (Domin 6540 p.p.* (mounted with *Rostellularia* specimen), *Domin 6541 & Domin 6544*). Not based on *S. rhombifolia* L. var. *atherophora* F. Muell., *Proc. Royal Soc. S. Austral.* 9: 213 (1886) (= *S. rohlenae*). (See under notes.)

Sida atherophora var. *brachypoda* Domin, *Biblioth. Bot.* 89: 391 (1928).
Holotype: *K. Domin 6546,* March 1910, Jericho, Great Dividing Range [Queensland] (PR, 2 sheets).

Sida magnifica Domin, *Bibliothec. Bot.* 22: 392(1928); Hnatiuk, *Census Austral. Vasc. Pl.* 309 (1990) — for typification see ssp. *magnifica* below.

?Sida dallachyi C.T. White, *Proc. Royal. Soc. Qld* 47: 54 (1936); Hnatiuk, *Census Austral. Vasc. Pl.* 309 (1990) — for typification see ssp. *magnifica* below.

?Sida cordifolia var.*? mutica* Benth., *Fl. Austral.* 1: 197 (1863); F.M.Bailey, *Compr.Cat.Qld Pl.* 57 (1913) –

Sida mutica (Benth.)Domin, *Bibliothec. Bot.* 89: 391 (1928) nom.illeg. predated by *S. mutica* Delile (1812)

Sida rohlenae var. *mutica* (Benth.)Fryxell, *Sida.*12: 26 (1987)p.p. (at least with respect to type material); Hnatiuk, *Census Austral. Vasc. Pl.* 309 (1990)p.p. — for typification see ssp. *magnifica* below.

Key to subspecies of *Sida atherophora* Domin

Mericarps with long retrorsely barbed awns; flowers with petals 6.5 mm long ....ssp. ***atherophora***
Mericarps lacking any awns, with stellate hairs along apical groove; flowers with petals 10–12 mm long .... ssp. ***magnifica***

Sida atherophora Domin ssp. *atherophora*

Distribution

Found in south-eastern Queensland, but extending as far north as Charters Towers and as far west as Charleville.

Ecology

Ecological notes include *Eucalyptus crebra* woodland with grassy understorey, disturbed mulga, *Eucalyptus populnea* woodland with dense grass stratum in red earth. Flowering March to June (rarely Sept).

Specimens examined:

AUSTRALIA. QUEENSLAND: *E.R. Anderson 3428*, 9.vi.1983, "Kairoo" vegetation monitoring site, c. 60km north of Dingo (BRI); *M.E. Ballingall 2144*, 12.v.1986, 4.8km west of Westmar on Moonie Hwy (BRI); *S.T. Blake 7953*, 7.111.1935, Minerva, north of Springsure (BRI,CANB) *S.T. Blake 6049*, 10.vi.1934, Pentland (BRI); *S.T. Blake 8532*, 11.iv.1935, near source of Poison Creek, c. 90 miles N of Hughenden (BRI); *S.T. Blake 10236*, 27.xi.1935, Jericho (BRI); *S.T. Blake 6956A*, 22.vii.1934, Minerva (BRI); *M.P. Bolton 619*, 13.vi.1986, S of Charters Towers, Doongara Stn (BRI); *E. Bowman 2*, s.dat., Neerkool Creek (MEL53499); *A. Dietrich s.n.*, 1863–74, Without locality (NSW194545); *S.L. Everist 2514*, 3.iv.1946, Comet (BRI); *R. Henderson 229*, 4.iv.1967, Area surrounding State Wheat Board at Moura (BRI); *L. Leichhardt 434*, 14.ii.1847, Expedition Range (NSW); *R.W. Purdie & D. Boyland 26*, 23.v.1976, 23km from Charleville along Charleville–Boatman Road (BRI,CANB); *R.H. Rebgetz 467*, 1980, Warrigal Creek near Pentland (BRI); *A.C. Robinson s.n.*, 15.xii.1974, Fairbairn Dam (BRI); *L.S. Smith & S.L. Everist 971*, 24.x.1940, About 3 miles E of Jericho (BRI); *L.S. Smith & S.L. Everist 992*, 24.x.1940, About 6 miles E of Jericho (MEL,BRI); *J.E.Young s.n.*, x.1917, between Emerald

and Longreach (BRI054219); *C.T. White 8655 p.p.*, 19.iii.1933, Torrens Creek (BRI); *C.T. White 10826*, iv.1937, Callide Range (BRI); *C.T. White 11773*, 6.ix.1941, Morven (BRI).

Sida atherophora ssp. magnifica(Domin)R.M. Barker, comb. et stat. nov.

BASIONYM: *Sida magnifica* Domin, *Bibliothec. Bot.* 22: 392(1928); Hnatiuk, *Census Austral. Vasc. Pl.* 309 (1990).

Holotype: *K. Domin 6548*, Feb. 1910, apud fl. Walsh River pr. opp. Chillagoe [Queensland] (PR); isotype: PR.

?*Sida dallachyi* C.T. White, *Proc. Royal. Soc. Qld* 47: 54 (1936); Hnatiuk, *Census Austral. Vasc. Pl.* 309 (1990).

Holotype: *L.J. Brass 2449*, 11.iv.1932, Mt Molloy [Queensland] (BRI, labelled as co–type by White); paratypes: *J. Dallachy s.n.*, 24.vi.1866, Herbert River [Queensland] (MEL53572); *J. Dallachy s.n.*, s.dat., Rockingham Bay [Queensland] (MEL53571) - both specimens annotated by White; ?isoparatype: *J. Dallachy s.n.*, s.dat., Rockingham Bay (MEL53570) - appears to be a duplicate of MEL53571.

?*Sida cordifolia* var.? *mutica* Benth., *Fl. Austral.* 1: 197 (1863); F.M. Bailey, *Compr.Cat.Qld Pl.* 57 (1913) – *Sida mutica* (Benth.)Domin, *Bibliothec. Bot.* 89: 391 (1928) nom.illeg. predated by *S. mutica* Delile (1812).

Sida rohlenae var. *mutica* (Benth.)Fryxell, *Sida*.12: 26 (1987)p.p. (at least with respect to type material); Hnatiuk, *Census Austral. Vasc. Pl.* 309 (1990)p.p.

Syntype (possible holotype): *F. Mueller s.n.*, s.dat. [1856], Macarthur River, Gulf of Carpentaria [Northern Territory] (K).

Distribution

S. atherophora ssp. *magnifica* is known from the Atherton to Townsville area in northern Queensland, with a single disjunct collection by Mueller from the McArthur River in the Northern Territory. This collection has closer affinities with this taxon than any other in Australia.

Ecology

Ecological annotations are almost completely lacking on the few specimens of this taxon which exist. The only information available is given is on a Magnetic Island collection where it is recorded from the landward side of coastal dunes. Flowering March – June.

Typification

1. *Sida magnifica* Domin

There are two sheets in Prague, only one of which has a label. The second sheet has the same herbarium number as that of the labelled sheet. The labelled sheet has two branches, each with long pedicelled fruits and each with a single flower with petals c. 2 cm long, while the second sheet bears a much more robust specimen with a number of branches and flowers. The labelled sheet has been treated as the holotype.

2. *Sida dallachyi* C.T.White

In the protologue, White designated the Brass collection as type, and so it has been annotated as the holotype of the species. It consists of two branches with fruiting pedicels in most of the axils and a single, somewhat broken flower, smaller than that associated with the type of *S. magnifica.*

White also listed Dallachy collections in MEL which had been collected on the 24th June 1866 as representing this species, but did not designate them as types. Five such collections exist in MEL but only two have been annotated by White and these can be considered as paratypes. Of the other three, MEL 53570 has the same information on it and the material matches that on the paratype sheet, MEL53571, and so it is probably a duplicate of that collection. Since it has not been annotated by White, it is considered to

be a probable isoparatype. One of the other two sheets has a collection date of 16th June 1865 (MEL53569) and has been annotated by Mueller as Sida melhamia[v]ea. The last sheet (MEL53567) is part of the Sonder herbarium and has been similarly annotated as Sida melhamia[v]ea; it appears to be a duplicate of MEL53567 and because of the different date, neither of these is considered to have any type status.

3. *Sida cordifolia* var. *mutica* Benth.

The type of *Sida cordifolia* var. *mutica* Benth. which is the basionym for *Sida rohlenae* var. *mutica* (Benth.)Fryxell and *Sida mutica* Domin cannot be placed altogether satisfactorily in this classification. It has the same muticous fruits as *S. atherophora* ssp. *magnifica* and *S. rohlenae* ssp. *occidentalis* as distinguished here. It differs from *S. rohlenae* ssp. *occidentalis,* where it was previously placed, by lacking any of the longer simple hairs characteristic of the WA populations having instead a similar indumentum to that of *S. atherophora* ssp. *magnifica.* Its shorter, more crowded pedicels are more like those of *S. spinosa,* from which it differs in its overall indumentum on the stems and leaves and by the lack of dense upright stellate hairs on the shoulder and awns of the mericarps. Apart from flower size, it resembles most closely specimens which have been segregated as *S. atherophora* ssp. *magnifica* in this treatment, particularly those types of *S. dallachyi* which is here treated as a synonym of S. *atherophora* ssp. *magnifica.* It is possible that *S. atherophora* ssp. *magnifica* and *S. dallachyi* are distinct taxa (see Note 1 below) since the types vary in indumentum and length of pedicels. However the number of herbarium specimens is small, they were mostly collected many years ago, and there has been no opportunity to investigate them in the field, and so the status quo is adopted here.

Notes

1. The Brass and Dallachy collections, representing *Sida dallachyi,* are relatively uniform in vestiture and habit and are at odds with the type of *S. magnifica* which has the close tomentum of ssp. *occidentalis* topped with occasional larger stellate hairs. Doubt has to exist as to whether *S. dallachyi* and *S. atherophora* ssp. *magnifica* are truly synonymous but the lack of extra collections makes it difficult to decide. Those few extra collections which do exist agree more closely with types of *S. dallachyi* than the type of *S. atherophora* ssp. *magnifica* as does the type of *S. cordifolia* var. *mutica* (q.v.).

2. Domin's *S. mutica* is based upon the same Mueller collection as *S. cordifolia* var. *?mutica* Benth. This collection has been annotated as "*S. brachypoda* ferd. Mueller" by Mueller. This is a completely different species to the *S. brachypoda* described by Holland & Reynolds (1988), which has also been attributed to Mueller in the past.

Specimens examined:

AUSTRALIA. QUEENSLAND: *Anon.(?R.C. Burton, ex herb. W.R.A. Baker) s.n.*, s.dat. Walsh Ranges (MEL112605); *Anon. s.n.,* s.dat., without locality (MEL53568); *Bancroft 34,* 1908, Stannary Hills (BRI p.p.); *Barclay Miller s.n.*,v.1891, Walsh (BRI p.p.); *C. Weld.Birch & A. Zelling s.n.*, 1892, Tait River (MEL111763); *S.T. Blake 8264,* 26.iii.1938, Magnetic Island (BRI); *R.C. Burton s.n.*, s.dat., Walsh Ranges (BRI); *J. Dallachy s.n.*, 24.vi.1866, Rockingham Bay(BRI ex MEL, MEL53570, MEL53572, MEL53569, MEL53571, MEL53567); *N.A.R. Pollock s.n.*, s.dat., Home Hill, Townsville (BRI); *Walsh s.n.,* s.dat.,Walsh Range (NSW 194543); *C.T. White s.n.*, 10.ii.1918, Magnetic Island (BRI).

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NOTES ON *ZYGOPHYLLUM* (ZYGOPHYLLACEAE) IN AUSTRALIA INCLUDING THE DESCRIPTIONS OF FIVE NEW SPECIES AND ONE NEW SUBSPECIES, REVISED KEYS AND TYPIFICATIONS

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Abstract

Two new species, *Z. eichleri* R.M. Barker and *Z. rowelliae* R.M. Barker, are described from within the 5-merous group of *Zygophyllum* species, together with a revised key to this group. *Z. halophilum* R.M. Barker, *Z. reticulatum* H. Eichler ex R.M. Barker and *Z. aurantiacum* ssp. *simplicifolium* H. Eichler ex R.M. Barker are described from the group of species with 4-winged fruits and a revised key is also provided to this group. *Z. marliesiae* R.M. Barker, closely related to *Z. prismatothecum*, is distinguished for the first time. Typifications and notes on other Australian species are also presented.

Introduction

An earlier paper (Barker 1996) documented some of the manuscript names of Hj. Eichler within the Zygophyllaceae of Australia. Many of these names were already in use since there were collections which had been annotated with them and Eichler had chosen and segregated types. The following paper continues to document new taxa within *Zygophyllum*.

Z. reticulatum and *Z. aurantiacum* ssp. *simplicifolium* were named and at least partially segregated by Eichler but in a less obvious way to those species published in the earlier paper. As will be seen from this treatment there still remain problems with the taxonomy of *Z. reticulatum*.

A mixture of *Z. eichleri* and *Z. rowelliae* was segregated within the CANB collections as the "Interior-North Western form of Z. iodocarpum", but this would appear to have involved both Eichler and his ABRS-funded assistant Alison Rowell. There were also occasional specimens which had been annotated earlier by Eichler as "aff. tesquorum" or "aff. iodocarpum" but these had not been segregated in any systematic way from the rest of the collections.

As was indicated in the earlier paper, the strength of the Eichler manuscripts did not lie in the provision of descriptions, but in the area of synonymy and a gathering of information on type material. While the author has seen type material that resides in Australia, the same cannot be said for material held in overseas herbaria. In these cases, however, there is invariably a photograph of these types within the manuscripts enabling discussion and choice of lectotypes, many of which are documented here.

The 5-merous species of *Zygophyllum*

The group of *Zygophyllum* species in which the parts are pentamerous had not been worked on to any great extent by Eichler and so when this project started the taxa still needed to be clarified. There is still some field work required to establish whether *Z. tesquorum* J.M. Black and *Z. retivalve* Domin, both documented here, are truly distinct. Similarly *Z. lobulatum* (F.Muell. ex Benth.)H. Eichler is almost certainly not deserving of species status, but it has been maintained here because its relationship with *Z. hybridum*

Tate and *Z. kochii* Tate is in need of clarification. Only limited material of all of these taxa is available.

Some of the leaf characters used to separate species in the past are known to be unreliable since they can be found on the one plant. The lobe on the outer edge of the leaflet towards the base, characteristic of *Z. lobulatum*, seems to occur mostly in older leaves. Consequently many of the leaves on one plant may be lacking the distinguishing character. The three-lobed leaflet apex, characteristic of *Z. kochii,* is also to be found in some specimens identified as *Z. lobulatum* (e.g. *R.M. Barker 1216*).

Two new species are recognised here for the first time. One, *Z. rowelliae*, is most closely related to *Z. iodocarpum* F.Muell., resembling that species in almost all characters, but possessing larger floral parts. The other, *Z. eichleri*, is most closely related to *Z. tesquorum*. A mixture of both of these new species had been segregated by Eichler and Rowell within the CANB collections as the "Interior-North Western form" of *Z. iodocarpum.*

Key to 5-merous *Zygophyllum* species

1 Capsule truncate at apex, with appendages on upper corner of each angle. Petals 10–15 mm long .... *Z. apiculatum*

1: Capsule rounded at apex, lacking appendages. Petals less than 10 mm long

- 2 Leaflets lobed at base on outer side
  - 3 Fruits 5–6 mm long, 1–2 seeds per cell; fruiting pedicel 10–12 mm long [Perth to Karratha] .... *Z. lobulatum p.p.*
  - 3: Fruits 8.3–11.5 mm long, 2–5 seeds per cell; fruiting pedicels 12–18 mm long [Lake Eyre region] .... *Z. hybridum*
- 2: Leaflets not lobed at base
  - 4 Leaflets 3-lobed at apex
    - 5 Corolla 5.5–7 mm long; fruit 8–13 mm long, somewhat angled at apex; seeds 2–4 per cell [inland WA from Pilbara to SA] .... *Z. kochii*
    - 5: Corolla 4 mm long; fruit 5–6 mm long, rounded at apex; seeds 1–2 per cell [Perth to Karratha] .... *Z. lobulatum p.p.*
  - 4: Leaflets entire or emarginate at apex
    - 6 Floral [fruiting] pedicel more than 5 mm long.
      - 7 Flowers white; fruits thin, not glaucous [central Australia] .... *Z. tesquorum*
      - 7: Flowers yellow; fruits thick-walled, glaucous [Kalbarri to Karratha area of W.A.] .... *Z. retivalve*
    - 6 Floral [fruiting] pedicel less than 5 mm long.
      - 8 Flowers and fruits single at each axil; fruits 6.5–8 mm long, 7.5–9.5 mm wide; style 0.5–0.6 mm long; leaflet apex rounded [inland WA, and central Australia] .... *Z. eichleri*
      - 8: Flowers and fruits paired at each axil; fruits 4–6 mm long, 5–7 mm wide; style shorter or longer than 0.5–0.6 mm; leaflet apex rounded or emarginate
        - 9 Leaflet apex emarginate; corolla 2.7–3.7 mm long; style 0.2–0.3 mm long; stigma 5-lobed [common, widespread Nullarbor to New South Wales and into central Australia] .... *Z. iodocarpum*
        - 9: Leaflet apex entire or emarginate; corolla 4–4.7 mm long; style 1–1.5 mm long; stigma entire [central Australia] .... *Z. rowelliae*

Zygophyllum tesquorum J.M. Black, *Flora of South Australia* 2: 334 (Jun. 1924).

Type citation: Lake Torrens; Far North. - Central Australia.

Lectotype here designated: Anon. [Tate on Horn Expedition] s.n., s.dat. [17.vi.1894], Deering Creek [South Australia] (AD97918157 p.p. - herb. Black, LHS specimen); *isolectotype*: AD96246172 - herb. Tate; *syntypes: Anon. [Tate on Horn Expedition] s.n.,* s.dat. [19.vi.1894], Mulga scrub SW of Mereena [Mereenie Bluff, Northern Territory]

(AD97918157 p.p. – herb. Black, RHS specimen, attributed to S.A.White; AD96246171 – herb. Tate).

Distribution & ecology

Confined to central Australian area with small incursions into S.A. (Deering Hills) and W.A. (Rawlinson Range), and possibly in the Norseman and Queen Victoria Spring areas of W.A. (see Note). Found in disturbed areas, often in calcareous soils with *Acacia kempeana, Triodia longiceps* and *Atalaya hemiglauca.* Flowering July - September.

Typification

There are two specimens in the Black Herbarium, both of which have been used to draw up the protologue. The larger branch represents the Horn Expedition collection from Deering Creek, while the smaller branch is a collection attributed by Black to S.A.White from "SW of Mereena". If White was the collector then it cannot be a Horn Expedition collection since White was not involved with that expedition. On a paper attached to the specimens Black refers to "FLS White" as the "collector of the Mereena specimen", and it is assumed that this is the source of the attribution of the collection to S.A.White.

There is further reference on this paper to the fact that there are "2 specimens in Tate Herb. in folder labelled Horn Exp." implying that both specimens should be attributed to that expedition. When these specimens were located it became quite clear that the two collections in the Black herbarium represent fragments taken from the original collections in the Tate herbarium. These collections both have locality details written by Tate and both would appear to be his own collections made on the Horn Expedition although there is not now any evidence except the locality and Black's comments to substantiate this. A pencilled annotation on the label of the Mereena collection may well be the source of the confusion with respect to the collector. The annotation is actually "Fls white", a distinguishing character for this species. Both of the Tate herbarium specimens have been annotated by Black as *Z. tesquorum.*

There is little difference between the two collections on the sheet in Black's herbarium (both have flowers and fruits) and so the larger fragment with correct collecting information has been designated as the lectotype.

Notes

1. A series of specimens from the Norseman area and from Queen Victoria Spring area appear to represent a disjunct occurrence of *Z. tesquorum.* Specimens are more depauperate, smaller in leaf and flower, and the pedicels closer to *Z. eichleri* in length, but the wing of the filaments, the flower colour and the shape of the stipular bract at each node (2-toothed vs entire) suggests that they are more closely related to *Z. tesquorum* than to *Z. eichleri.* This distribution represents a disjunction from both species.

WESTERN AUSTRALIA: *D.J. Pearson 1728,* 37 km WNW Queen Victoria Spring, Queen Victoria Spring Nature Reserve (PERTH); *G.J.Keighery & J.J. Alford 1059,* 41 km N of Trans Australia railway line on W boundary fence of Kananda Stn (PERTH); *T.E.H. Aplin 1827,* Jimberlana Hill, 8 km NE of Norseman (PERTH).

2. *Z. tesquorum* is very similar in habit to *Z. kochii* and *Z. iodocarpum.* It can be distinguished from the former by its narrower and entire leaflets. The plants are also more delicate, the capsule generally smaller, the petiole subterete and the flowers appear to be white rather than yellow drying white. It can be distinguished from *Z. iodocarpum* by its larger flowers, non-globular capsule and long pedicels in flower and fruit. It may not be distinct from the Western Australian coastal species *Z. retivalve* in any character bar the flower colour although Eichler separated the two on fruit size predominantly. The earlier name, if the two prove to be conspecific, is *Z. tesquorum.*

Selected specimens examined

AUSTRALIA. NORTHERN TERRITORY: *A.C. Beauglehole 22833*, Mt Connor, S.E.side (AD,DNA,MEL); *A.C. Beauglehole 24669*, 7.viii.1967, c. 165 km SW of Alice Springs (CANB); *A.C. Beauglehole 50637*, 17.v.1976, near Chilla Wells Bore, Tanami Desert Wildlife Sanctuary (CANB); *G.W. Carr 2217 & A.C. Beauglehole 45996*, 26.vi.1974, Gosses Bluff (CANB); *G. Chippendale NT2634*, 24.viii.1956, 40.9 mls W Hermannsburg (DNA,CANB); *G. Chippendale NT6505*, 13.viii.1959, 2 mls SW Huckitta HS (CANB,DNA); *Hj. Eichler 22636, 26.viii.1978*, 44 km from Alice Springs, Glen Helen turnoff (AD,CANB,DNA,L); *Hj. Eichler 22638*, 47 km from Glen Helen turnoff, 12 km before Ellery Creek crossing (CANB,MEL); *T. Henshall 190*, 7.v.1974, Victory Downs (CANB,DNA,PAUH); *P.K. Latz 4108*, 23.viii.1976, 4 mls E Wallera Ranch (CANB); *P.K. Latz 5147*, 5.vi.1974, 40 km SE Alice Springs (CANB,MEL,NT); *P.K. Latz 6317*, 16.x.1975, 35 km S Alice Springs (CANB,DNA); *M. Lazarides 5898*, 4.ix.1956, 15.5 mls NW of Lucy creek Stn (CANB); *D.J. Nelson 1752*, 9.ix.1968, Deep Well Rd, 17 mls S Alice Springs (CANB); *D.J. Nelson 2211*, 30.v.1972, 1.7 mls E Corroboree Rock, Ross Hwy (AD,B,CANB,DNA,K,MO,NT,PAUH); *F.C. Vasek 680914-5*, 14.ix.1968, 32 mls W of Alice Springs on Hermannsburg road (CANB).

SOUTH AUSTRALIA: *J.Z. Weber 220*, 1.xi.1966, Mt Davies Rd, c. 145 km W of Musgrave Park Stn and c. 50 km W of Piltady Camp (CANB).

Zygophyllum lobulatum (Benth.)H. Eichler in R.M. Barker, *J. Adelaide Bot. Gard.* 17: 168 (1996).

Basionym: *Zygophyllum iodocarpum* var. *lobulatum* Benth., *Flora Australiensis* 1: 293 (1863).

Type citation: W. Australia. Champion Bay, Oldfield.

Lectotype here designated: Oldfield s.n., s.dat., W. Australia, Champion Bay [Thonunoko] (MEL516551); *isolectotype:* K p.p.

Distribution & ecology

Occurs on the west coast of W.A. from Swan River to Coral Bay. It has been recorded from red sand or loam, sometimes associated with limestone, within *Acacia* shrubland. Flowers July to September.

Typification

The specimen in MEL was seen by Bentham and is annotated as "Zygophyllum lobulatum ferd. Mueller" and as "Z. iodocarpum var?" by Mueller, but bears no annotations by Bentham; it consists of three flowering plants and the leaflets on most leaves are lobed basally. On the other hand, the specimen in K consists of a single flowering plant mounted with a collection from the Elder Exploring Expedition and has been annotated as "Zygophyllum iodocarpum var?" by Bentham. The annotation, var. *lobulatum* Benth., seems to have been made at a later stage, and not by Bentham; only one or two of the older leaflets have the lobed base. Despite the fact that Bentham did not attribute the varietal name "lobulatum" to Mueller, there can be little doubt that it should be because of the annotations on the MEL sheet. Although he did not name it, Mueller also mentioned this particular specimen under *Z. iodocarpum* in his Plants of the Colony of Victoria (1862) as

> "very similar to the species above described [Z. iodocarpum], of which it may only be a variety, differing in having externally a small basal lobe protruding from most of the leaflets and also one or the other terminal teeth, and in producing solitary pedicels about ½ inch long or even longer."

The MEL specimen has been chosen as lectotype for several reasons. It has been annotated with the epithet "lobulatum" clearly attributed to Mueller, it has been seen by Bentham and there is more material than on the K specimen. In addition most leaves have a lobe at the base of each of the leaflets.

Notes

There has to be some doubt as to whether this taxon is deserving of species level. It is very closely related to *Z. kochii* and *Z. retivalve* with which it overlaps in distribution; it would appear to differ only in leaf and flower sizes. The lobe at the base of the leaflet is not always present on all leaves, but is more likely to be observed on larger and older leaves (suggesting a development with age). This characteristic would suggest a relationship to *Z. hybridum* as well, but the fruits in that species are much larger and are elliptic and it is confined to the Oodnadatta region of South Australia. With further collections and field studies it might be more appropriate to treat *Z. kochii, Z. retivalve, Z. lobulatum,* and possibly *Z. hybridum,* at an infraspecific level, but for the moment the species level has been retained.

Z. lobulatum is distinct from *Z iodocarpum* by its longer pedicels, single flowers per axil and possibly by the wing appendages of the stamens and from *Z. tesquorum* by the lobed leaflets and yellow flowers.

Selected specimens examined

AUSTRALIA. WESTERN AUSTRALIA: *R.M. Barker 1028,* 23.viii.1995, Great Northern Hwy, 7.6 km N of Ningham HS turn-off, SW of Paynes Find (AD, 4 dupl.); *R.M. Barker 1216,* 7.ix.1995, NW Coastal Hwy, km S of Overlander Roadhouse (AD); *R.M. Barker 1224,* 7.ix.1995, NW Coastal Hwy, c. 9 km N of Billabong Roadhouse (AD); *Hj. Eichler 23622,* S of Coral Bay (AD, CANB, NSW, PERTH); *Hj. Eichler 23623,* 3.ix.1985, S of Coral Bay (CANB); *Hj. Eichler 23642,* 5.ix.1985, 26.9 km S of Wooramel (AD, CANB, PERTH); *Hj. Eichler 23644,* 5.ix.1985, 17 km S of Overlander Roadhouse (CANB); *Hj. Eichler 23647,* 5.ix.1985, c. 0.5 km N of No. 18 Bore, Hamelin Stn (CANB); *Hj. Eichler 23656,* 9.ix.1985, Along roadside from NW Coastal Hwy to Kalbarri, 1.5 km E of Kalbarri Information Bay (CANB); *Hj. Eichler 23656A,* 9.ix.1985, Along roadside from NW Coastal Hwy to Kalbarri, 1.5 km E of Kalbarri Information Bay (CANB); *D. & N. McFarland s.n.,* 20.viii.1978, Kalbarri N.P., c. 16.5 km SSE of Red Bluff Caravan Park on disused track, 2.5–3 km N of Vermin Fence (CANB); *S. & E. Pignatti 112,* 19.viii.1990, C. 4 km S of Overlander Roadhouse (c. 500 m E of Coastal Hwy) (CANB); *G.L. Throssell s.n,* Sept. 1953, Mendel via Mullewa (PERTH); *D. & B. Bellairs 2181,* 14 km S of Kalbarri (PERTH).

Zygophyllum kochii Tate, *Trans. Royal Soc. S. Australia* 23: 291 (1899).

Type citation: Near Mount Fitton and Trinity Well, *J. Langley.*

Lectotype here designated: J. Langley (herb. M. Koch 469), August 1899, [South Australia] Mt Lyndhurst, near Mt Fitton, also near the Trinity well. sepals 5 petals 5 (these about 2 lines long, those of [Koch] 165 & 332 are smaller!) fruit 5-angled, with narrow membranous almost wing-like angles. 4 seeds in each cell. (AD97918101, herb. Tate); *isolectotype:* AD97904148, herb. J.M. Black; *possible isolectotypes: M. Koch 469,* August 1899, Mt Lyndhurst (K–2 sheets, BM – seen as photographs in Eichler MS); *Probable syntype: M. Koch 469,* September 1899, Mt Lyndhurst. First found by the collector (AD97904149, herb. Tate).

Distribution & ecology

Inland Western Australia from the Pilbara region to northern South Australia. Found in gravelly clay soils in low lying areas in mulga. Flowering July-September.

Typification

In the protologue, Tate attributed the collection of this species to J. Langley and there is one collection in the Tate herbarium which accords with this. This specimen was clearly given to Tate by Koch since all of the collecting details are written by Koch on one of his printed labels but with his name as collector scored through and replaced by "J. Langley" . Koch himself collected the species in the following month and this collection was also given the same number, 469, as the holotype (Koch's numbers are species numbers, not

collecting numbers). The collection has been annotated as "Zygophyllum Kochii, Tate. Oct. 1899" by Koch and formed part of the Tate herbarium and so it is quite possible that it also formed part of the material available to Tate in drawing up the protologue. Because of this possibility the Langley collection has been designated as lectotype rather than holotype. It consists of 7 pieces of plant with both flowers and fruits present. The isolectotype in the Black herbarium consists of 2 fruits and mounted floral parts together with J.M. Black's drawings of them. These were removed from the lectotype sheet and used by J.M. Black to draw up his own description for the Flora of South Australia. The three sheets from K and BM, seen as photographs, bear no indication that they were collected by Langley, but they were collected in August and so they are also possible isolectotypes.

There are almost certainly further sheets in herbaria other than those already cited bearing the *Koch 469* label, but only those collected in August can be considered as isolectotypes.

Notes

Z. kochii is distinctive by its 3-lobed leaflets; its fruits can be erect or drooping on long pedicels and they are less rounded than in other taxa of this complex, being closer to oblong rather than elliptic in shape. There is sometimes the suggestion of a small apiculum (similar to that in *Z. apiculatum* fruits) at the upper outer edge of each of the angles of the fruit and the 5 "ribs" of the fruit can sometimes appear to be very narrowly winged.

Specimens examined

AUSTRALIA. WESTERN AUSTRALIA: *R.M. Barker 1054*, 25.viii.1995, km N of Mt Magnet (AD); *A.C. Beauglehole 59625 & E.G. Errey 3325*, 14.ix.1978, 6 km S of Agnew, Leonora Rd (CANB); *C.D. Boomsma 618*, 6.viii.1980, 2 km SW of Paraburdoo (AD); *R.J. Cranfield 5541*, 9.viii.1986, Beefwood Well, Yoothapina Stn (CANB); *G. Howard [D. Symon 5815]*, 4.vi.1968, N of Lake Carnegie, 64.4 km W of Carnegie HS (AD); *C. Teichert 4*, ix.1948, NE part of Kennedy Range, Gascoyne Area (MEL); *P.G. Wilson 8407*, 29.vii.1969, 82 km E of Carnarvon near Doorawarrah HS (CANB); *P.G. Wilson 11987*, 6.ix.1984, c. 80 km W of Carnegie on road to Wiluna (CANB, PERTH).

SOUTH AUSTRALIA: *R. Bates 14736*, 11.vii.1988, Mt Fitton Talc Mine (AD); *R. Bates s.n.*, 30.vii.1989, Billeroo Stn (AD98946188); *G.H. Bell 1349*, 17.ix.1987, Slopes of hill on N side of Nent Oura Research Unit, Mt Freeling Stn (AD); *J. Carrick 1812*, 15.viii.1968, c. 22.5 km ENE of Lyndhurst (AD); *B. Copley 3654*, 7.ix.1971, c. 1 km W of Shearing Shed at Wearing Ruins north of Wirrealpa (AD); *Hj. Eichler 18645*, 8.iv.1966, c. 3 km W of Mt Lyndhurst HS (AD); *T.R.N. Lothian 3509*, 14.xi.1964, c. 1.6 km W of Landmark Tank, near Terminaton Well (AD); *R. Swinbourne 155*, 7.ix.1968, near Andamooka Opal Field airstrip (AD).

Zygophyllum hybridum Tate, *Trans. Royal Soc. S. Australia* 23: 291 (1899), p.p. (excluding the Elder Expedition collection from Cootanoorina); Koch, *Trans. Royal Soc. S. Australia* 24: 81 (1900); J.M. Black, *Trans. Royal Soc. S. Australia* 41: 643 (1917); Black, *Fl. S. Austral.* 334 (1924); 2nd ed. 489 (1948); Ising, *Trans. Royal Soc. S. Australia* 81: 168 (1958); Eichler in Jessop & Toelken (eds) *Fl. S. Austral.* 2: 732 (1986).

Type citation: Mount Lyndhurst Run, Far North; "grows on loose loamy soil, hence is seen at its best only in very wet seasons" (Mr M.Koch); also Cootanoorina (Elder Exped. as *Z. glaucescens*, var.).

Lectotype here designated: *M. Koch 332,* August 1899, Mount Lyndhurst Run, Far North {South Australia] (AD s.n.); *isolectotypes*: BM, K, MEL95283, AD97904147; *syntypes: M. Koch 332*, Sept. 1898, Mount Lyndhurst (AD96851098); *M. Koch 332*, Oct. 1898, Mount Lyndhurst (MEL95284); *M. Koch 332*, July 1899, Mount Lyndhurst (AD96851103); Excluded syntype (= *Z. iodocarpum* F.Muell.): *R. Helms (Elder Exploring Expedition) s.n.*, 7 May 1891, Cootanoorina (NSW145337; *possible syntype:* NSW145338).

Distribution & ecology

Z. hybridum is confined to the Oodnadatta–Maree region of South Australia and is listed on the Rare and Threatened Australian Plant (ROTAP) list. It is recorded from clay soil of gibber plains, but only appears in very wet years. Flowering May to August.

Typification

In the protologue, Tate identified a Koch collection from Mt Lyndhurst and one from Cootanoorina (Elder Expedition as *Z. glaucescens* var.) as *Z. hybridum*. Neither collection was identified any further. There are a number of Koch collections bearing the number 332 but this is a "species number" rather than a collection number, since the collections all bear different dates.

The majority of specimens bearing this number were collected in August 1899 (BM, K, MEL95283, AD97904147 and AD s.n.) and have been annotated by Koch as "Zygophyllum hybridum Tate Oct. 1899, new species...first found by the collector". The only one of these to have possibly been annotated by Tate is the sheet AD s.n. which bears the annotation "Zygophyllum sp." by Koch, followed by the annotation "hybridum" in a different hand and a different pen. This specimen has been designated as the lectotype.

The collection from Cootanoorina from the Elder Expedition, referred to by Tate and housed in NSW, would appear to be a collection of *Z. iodocarpum* F.Muell. It bears the annotation "Z. glaucescens FvM., small-flowered var." but has no indication on it that it was seen by Tate. Three duplicates of this collection, also housed in NSW, do not bear the annotation.

Notes

A very distinctive species due to the shape of the leaves. *Z. hybridum* is most closely related to *Z. kochii* from which it differs by the entire rather than 3-lobed apex of the leaflet and by the presence of a lobe at the base of the outer side of each leaflet. Fruits have been recorded as erect in this species, as they have in *Z. kochii* and *Z. lobulatum,* but this character needs investigation in the field. Both *Z. kochii* and *Z. hybridum* have 4–5 ovules per cell while *Z. lobulatum* has only 1–2 ovules per cell. Seed of *Z. kochii* is black and shiny.

Specimens examined

AUSTRALIA. SOUTH AUSTRALIA: *F.J. Badman 6987*, 10.viii.1993, Allandale Stn, 2 km WSW of Mt Arthur (AD); *M.E. Ballingall 2254*, 13.ix.1986, Nilpinna Stn, S of Oodnadatta on W side of main track (AD); *R.J.-P. Davies 676*, 21.viii.1983, Mt Barry Pastoral Lease, on SE side of Oodnadatta-Mt Barry Rd between Camel Creek and Aloorina Creek crossings, (AD); *T.S. Henshall 3221,* Allandale Stn, 36 km SW of Oodnadatta, (CANB,NT); *E.H. Ising s.n.*, 7.ix.1931, Oodnadatta (AD966031683); *E.H. Ising 3926*, 30.vii.1952, Fish Hole, 20 miles S of Oodnadatta (AD); *S.A. White s.n.*, 17.ix.1916, Mt Hopeless (AD97904146).

Zygophyllum retivalve Domin, *Bibliotheca Botanica* 89: 281 (Oct. 1926).

Type citation: Nordwest-Australien: zwischen Ashburton und De Gray River, *E. Clement*.

Lectotype here designated: E. Clement s.n., s.dat., Between the Ashburton and De Gray rivers [Western Australia] (PR); *isolectotype*: K. Both specimens seen as photographs in Eichler MS.

Zygophyllum sp. Karratha (J.S. Beard 3508), W.A. Herbarium Census.

Zygophyllum sp. 1 (Karratha, Coral Bay, H. Eichler 23621), Briggs & Leigh, *Rare or Threatened Australian Plants* 188 (1995).

Distribution & ecology

Occurs in Kalbarri to Karratha area of W.A. Recorded from limestones rises and from flat stony clay. Flowers July-September.

Typification

The lectotype specimen consists of 4 plants with flowers and fruits. The accompanying label has been annotated by Domin as "Zygophyllum n. sp. filaments without wings/ not fruticulosum/ neither billardieri, which has truncate capsules, not Kochii (leaflets entire)", whereas the equivalent specimen in K has merely been labelled as "Zygophyllum n. sp."

Notes

For discussion of this species see Barker 1996. *Z. retivalve* does not appear to be markedly distinct from *Z. tesquorum* (q.v.).

Specimens examined

WESTERN AUSTRALIA: *R.M. Barker 1222,* 7.ix.1995, NW Coastal Hwy, c. 34 km S of Overlander Roadhouse (AD); *Hj. Eichler 23621*, S of Coral Bay (AD, CANB, HO, L, MO, PERTH, NSW); *P. Glennon 62,* Peg's Creek, Karratha (PERTH); *D.W. Goodall 1162,* 2 km W of Learmonth (PERTH); *N.S. Lander 1367, B.A. Fuhrer & P.S. Short,* E side of Kennedy Range (MEL1556210).

Zygophyllum eichleri R.M. Barker, sp. nov.

Species nova proxima *Z. tesquoro* sed differt pedicellis brevioribus et floribus flavis.

Holotype: *Hj. Eichler 23578*, 19.viii.1985, 91.4 km N of Kumarina Mine, Western Australia (AD); isotypes: CANB, MEL, NSW, PERTH.

Z. iodocarpum auct. non F. Muell., reference to specimens from NT and WA which have been referred here in the past.

Decumbent or prostrate, spreading glabrous annual *herb*, to 20 cm high, wider than high. *Leaves* petiolate; leaflets succulent, obovate, sometimes broadly so, 5.5–15 mm long, 2.8–8.5 mm wide, continuous with petiole and not articulated at base, rounded to obtuse at the apex, sometimes with fragile acumen; petiole 5–15 mm long, narrowly winged. *Flowers* single at each node. *Pedicel* 2–3.5 mm long in flower, erect, 2–6.5 mm long in fruit. *Sepals* 5, 2–3.5 mm long. *Petals* 5, yellow, aging white, obovate to spathulate, 3.7–5.3 mm long, longer than sepals. *Stamens* 10; filaments 1.7–2.2 mm long, winged basally, wing apex widened and toothed; anthers 0.7–0.9 mm long. *Disc* 5-lobed, entire, sinuate, succulent, papillose on margin. *Ovary* 5-angled, 5-celled, glabrous; stigma minute, 5-lobed. *Capsule* pendent, transversely broadly elliptic, 6–8 mm long, 5-angled, 5-celled, rounded at apex, with 1 seed per cell; *seeds* smooth, pale to dark brown, not markedly shiny; fruiting style 0.5–0.6 mm long. Fig. 1 A–F.

Distribution & ecology

Central Australia from Alice Springs region through to Oakover River and Carnegie region of Western Australia and Musgrave and Mann Ranges of South Australia. Occurs in rocky areas, often in red sand amongst scattered mulga, or in calcareous areas with *Eucalyptus transcontinentalis*. Flowering June-September.

Note

It would appear that ~~that~~ the *Zygophyllum iodocarpum/tesquorum* group of species had not been studied intensively by Eichler. He had annotated the Carolin specimen (*Carolin*

5224) as "Zygophyllum sp. nov. aff. Z. iodocarpum" in 1967 and his own collection (*Eichler 23578*) is also labelled as Z. "aff iodocarpum" as are the collections *George 8764* and *Donner 4413*. *Wilson 2556* is labelled as Z. "cf. iodocarpum". However the rest of the collections were all treated as *Z. iodocarpum* F.Muell. Some specimens had been segregated, probably by Alison Rowell rather than Eichler, as the "Interior-North Western form" of *Z. iodocarpum*, but this folder consisted of a mixture of *Z. eichleri* and *Z. rowelliae* as recognised here.

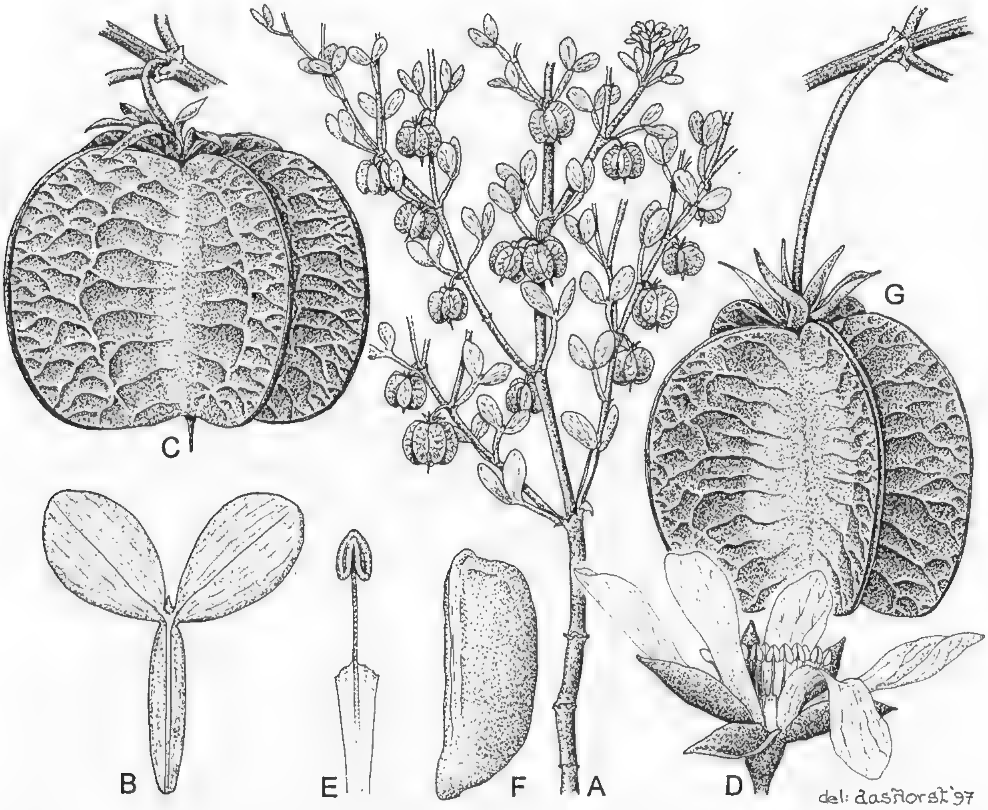

Fig. 1. ***Zygophyllum eichleri*** R.M. Barker. **A,** habit ×0·75; **B,** leaf ×3; **C,** fruit ×5; **D,** flower ×5; **E,** stamen ×14; **F,** seed ×14. (**A–F,** *M. Lazarides 5898*, CANB); ***Z. tesquorum*** J.M. Black. **G,** fruit with pedicel ×5. (**G,** *F.C. Vasek 680914-5*, CANB).

Distinguishing features and relationships

Z. eichleri is clearly distinguishable from *Z. tesquorum* by the length of the pedicel in both flower and fruit. In addition, leaves tend to be wider and the filament wing is toothed at the apex. The flower colour is apparently also different since *Z. eichleri* has yellow flowers aging white whereas records of *Z. tesquorum* are of white flowers only. The two taxa do cohabit. The shape of the fruit and the length of the pedicel in *Z. eichleri* are more like those of *Z. iodocarpum* and *Z. rowelliae*, possibly accounting for the confusion with *Z. iodocarpum* previously. Both of these species can be readily distinguished by the paired fruit at each node while they are single in *Z. eichleri*. *Z. iodocarpum* differs also by its much smaller flowers (petals 2.7–3.7 mm long), shorter styles (0.2–0.4 mm long) and the

leaflet apex often being emarginate. *Z. rowelliae* can be distinguished by its longer style (1–1.5 mm long).

Specimens examined

AUSTRALIA. NORTHERN TERRITORY: *R.C. Carolin 5224*, 17.viii.1966, c. 15 miles E of Curtin Springs (AD, SYD); *N.N. Donner 4413*, 24.viii.1973, Mt Olga, W side at Docker River Rd junction (AD); *Hj. Eichler 22636*, 44 km W of Alice Springs (turnoff to Glen Helen) (CANB, DNA); *P.K. Latz 6317*, 35 km S of Alice Springs (CANB, DNA); *M. Lazarides 5898*, 15.5 mls NW of Lucy Creek Stn (CANB, DNA).

SOUTH AUSTRALIA: *W.R. Barker 3169*, C. 6 km by vehicle ENE of Mt Moulden on track to Kuntjana (AD); *N.N. Donner 6478*, C. 1 km SW of Krewinkel Hill, which is c. 75 km NW of Mt Lindsay, beside road to Pipalyatjara (AD); *P.G. Wilson 2556*, 10.viii.1962, Foot of Mt Woodroffe (AD, CANB, AK).

WESTERN AUSTRALIA: *A.M. Ashby 3571 [Stan Gratte's party]*, 2-14.viii.1970, Carnegie Stn (AD); *R.M. Barker 1081*, 28.viii.1995, Newman-Marble Bar Rd, 2.1 km from turnoff from Great Northern Hwy (AD, PERTH); *R.M. Barker 1086*, 28.viii.1995, Newman-Marble Bar Rd, 27.2 km from turnoff from Great Northern Hwy (AD); *R.M. Barker 1120*, 30.viii.1995, Karijini NP, c. 11 km along Mt Bruce Road from Park Visitor Centre end, c. 11 km E of Mt Bruce (AD, PERTH); *W.R. Barker 2075*, 24.viii.1977, Upper Carawine Gorge, c. 1 km N of road crossing of main channel of Oakover River (AD); *A.S. George 4609*, 2.vii.1963, 9 miles E of The Gap (Rutter's Grave), E of Laverton (PERTH); *A.S. George 8764*, 18.vii.1967, Wingelinna Mining Camp (AD, PERTH); *N.H. Speck 973*, 15.vii.1958, 10 miles S of Berringarra (CANB).

Zygophyllum iodocarpum F.Muell., *Linnaea* 25: 372 (Feb. 1853).

Type citation: In pascuis collinis lapidosis subsalinis prope Cudnaka et Wulpena.

Lectotype here designated: *F.Mueller s.n.*, Oct. [18]51, Cudnaka & Akava (MEL95286); *isolectotypes: F.Mueller s.n.*, s.dat., Akava [Arkaba] (MEL110970, herb.Sonder); *Dr M[ueller] s.n.*, Oct. [18]51, Akava [Arkaba] (MEL110965, herb.Sonder). This last specimen annotated "Petala 5 oblongo-cuneata lutea ??am X ejusdem voloris. Germen viresis" as well as with the name "iodocarpum ferd. Muell".

Zygophyllum hybridum auct. non Tate: Tate, *Trans. Royal Soc. S. Australia* 23: 291 (Dec. 1899), p.p. (only with respect to the Elder Expedition collection from Cootanoorina).

Distribution & ecology

Occurs in open areas, often on clay plains, alluvial flood plains or gibber plains, but also frequently found in bare areas within chenopod shrublands. Flowering April to August.

Typification

All three specimens in MEL qualify for choice as lectotype, but the one that Mueller chose to keep in MEL rather than those sent to Sonder has been designated as the lectotype. It has Mueller's handwritten notes attached to it and these bear more relationship to the protologue than the other two collections.

Distinguishing characters

Z. iodocarpum is usually easily recognised by the paired, shortly pendent, wider than high, often purple-tinged, 5-angled fruits with a very short 5-lobed style. Fig. 2G, H.

Representative specimens examined:

AUSTRALIA. NEW SOUTH WALES: *W.R. Barker 2631*, Barrier Range, c. 1/2 km by road S of Caloola Ck crossing by main Broken Hill-Tibooburra road (AD, dupl.).

NORTHERN TERRITORY: *T.S. Henshall 581*, Andado Stn (CANB, DNA, MO, NT, PAUH).

QUEENSLAND: *R.W. Purdie 537D*, Flat plain, 18 km NE of Yaralla (BRI).

SOUTH AUSTRALIA: *F.J. Badman 1427*, Gregory Creek, 75 km W of Marree (AD, CBG, MEL); *G.H. Bell 1034*, Yalpara Conservation Pk, NE corner, near entrance gate (AD, CBG, RSA).

VICTORIA: *J.H. Willis s.n.*, Boundary Point, extreme NW corner of Victoria (MEL95289).

WESTERN AUSTRALIA: *A.S. George 11873*, c. 47 km NNW of Cocklebiddy, Nullarbor Plain (PERTH).

Zygophyllum rowelliae R.M. Barker, sp. nov.

Species nova proxima *Z. iodocarpo* sed differt floribus maioribus, stylo longioro et indivisis stigmate.

Holotype: W.R. Barker 6016, 26.viii.1989, South Australia, Arckaringa Hills; c. 9 km by road E of turnoff into Arckaringa HS, then c. 0.9 km N along track and fenceline from gate. (27° 54' S, 134° 49'E). Common. Along creekline. *Acacia aneura* open woodland over *Eremophila* and *Cassia* spp. over herbs, small bushes and grasses over siliceous gravel over red-brown sandy loam. Dark green succulent plant. Petals deepish yellow, turning white after anthesis. Anthers deepish yellow. Material off several plants. (AD99103218); *isotypes:* CANB, DNA.

Z. iodocarpum auct. non F. Muell.; many authors, including H. Eichler in *Fl. S. Austral.* 2: 733 (1986) p.p. (only with respect to collections with styles 1–1.3 mm long and entire stigmas).

Initially erect, becoming decumbent and spreading, glabrous, annual, *herb*, to 25 cm high, wider than high. *Leaves* petiolate; leaflets succulent, obliquely obovate, 6–25 mm long, 2.5–14 mm wide, appearing articulate with petiole by the constriction of the widened petiole at its apex, rounded or emarginate at the apex; petiole 3.5–12 mm long, subterete or with narrow wing. *Flowers* paired at each node. *Pedicel* 1–3 mm long in flower, erect, 3–5 mm long in fruit. *Sepals* 5, c. 3 mm long. *Petals* 5, yellow, obovate, 4–4.7 mm long, longer than sepals. *Stamens* 10; filaments 2–2.4 mm long, winged at base, wing oblong, erose at apex; anthers 0.9–1.1 mm long. *Disc* 5-lobed, sinuate; lobes joined, succulent, papillose on apex. *Ovary* not angled or 5-angled, 5-celled, glabrous; style 1–1.3 mm long; stigma subcapitate, not lobed. *Capsule* pendent, transversely broadly elliptic, 4–5 mm long, 5-angled, 5-celled, rounded at apex, with 1(-2) seeds per cell; seeds minutely verrucose, 2.5–3.5 mm long, black, shiny; fruiting style 1 mm long. Fig. 2 A–F.

Distribution & ecology

Found in an area bounded by Noccundra in S.W. Queensland, Coober Pedy in South Australia and Ooraminna, just S of Alice Springs in the Northern Territory. Occurs in breakaways and dissected regions, often in gravelly soils. Flowering April to October, probably dependent on rain.

Notes

Z. rowelliae is very closely related to *Z. iodocarpum* and it may well represent an outcrossing variant. It can be distinguished from *Z. iodocarpum* by its somewhat larger flowers and the longer style with undivided stigma, visible in both flowers and fruits. None of the specimens seen had the red-purple blush so commonly associated with the fruits and branches of *Z. iodocarpum* but this character needs to be confirmed with field study. Other characters by which it differs are the tendency to have a subterete petiole and the paired flowers often being at different stages of development.

Etymology

Named after Alison Rowell, employed on ABRS funding, to assist Hansjoerg Eichler to work on *Zygophyllum*. Many of the notes on *Zygophyllum* within the Eichler manuscripts were made by her.

Specimens examined

AUSTRALIA. NORTHERN TERRITORY: *P.K. Latz 13420,* Ooraminna Range, (DNA,MEL); *P.K. Latz 6874,* Beddome Range, New Crown Stn (CANB,NT); *J.H. Willis s.n.*, 17.vii.1966, vicinity of Heavitree Gap camping area and Mt Gillen, c. 4 miles SW of Alice Springs (MEL95288).

SOUTH AUSTRALIA: *F.J. Badman 1055,* 23.v.1984, Evelyn Creek, 3 km E of Copper Hills H.S. (AD,CBG,MEL); *W.R. Barker 5950,* 24.viii.1989, Copper Hill Stn, c. 1.5 km directly E of HS (AD); *R. Bates 18861,* 6.vii.1989, hills N of Marla town (AD); *A.C. Beauglehole 25361,* 26.vi.1968, 56 miles N of Coober Pedy (AD); *P. Copley 921,* 15.viii.1984, Coober Pedy "Breakaway" c. 32 km NW of Coober Pedy, c. 2½ km NE of Shell Patch Bore (AD); *N.N. Donner 6684,* 14.ix.1978, c. 11 km by road SSW of Hawks Nest Well and c. 18.5 km by road N of Wintinna HS (AD,CANB); *E.H. Ising s.n.*, 3.viii.1955, Evelyn Downs (AD966150221); *E.H. Ising s.n.*, 2.viii.1955, Evelyn Downs (AD966150255); *E.H. Ising 1173 & R.H. Quin,* 30.vii.1920, Coober Pedy (AD); *R.H. Kuchel 632A*,4.viii.1963, c. 70 km W of Oodnadatta (AD,CANB); *T.R.N. Lothian 4365*, 9.vii.1968, C. 3 km N of Mt Willoughby HS (AD); *A. Robinson for NPWS 2683,* 25.vi.1989, Evelyn Creek on Copper Hills Stn, 10 km E of Mt Willoughby HS on Cadney Park to Oodnadatta road (AD).

QUEENSLAND: *D.E. Boyland 3128,* 13.vii.1971, 38.4 km SSE of Noccundra (BRI,MEL).

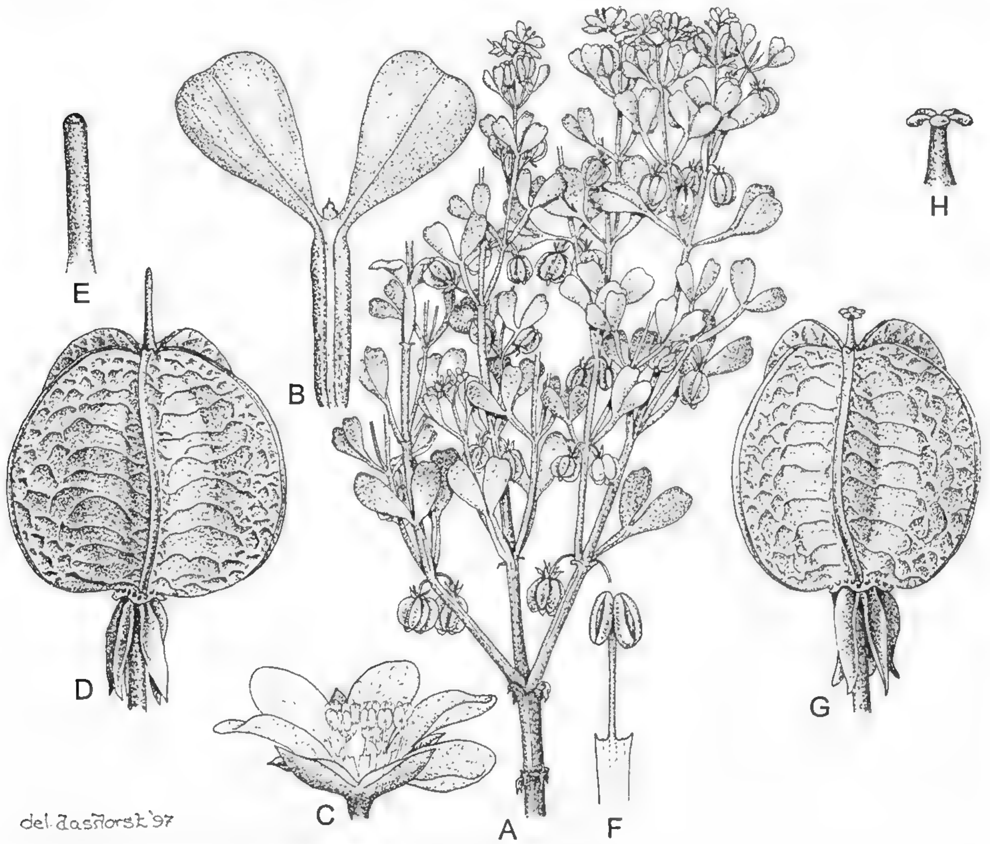

Fig. 2. ***Zygophyllum rowelliae*** R.M. Barker. **A,** habit ×0·75; **B,** leaf ×2; **C,** flower ×4; **D,** fruit ×7; **E,** style ×20; **F,** stamen ×14. (A–F, *W.R. Barker 5950*, AD); ***Z. iodocarpum*** F. Muell. **G,** fruit ×6; **H,** style ×20. (**G, H,** *L.D. Williams 10479*, AD).

The 4–merous species of Zygophyllum with winged fruits

The following key applies to all of those species of *Zygophyllum* in Australia with fruits with 4 vertical wings. These fruits are either dispersed entire without breaking up or

dispersed as 4 single-winged segments. Unlike other species of *Zygophyllum,* where it is the seeds which are dispersed, in this case the endocarp and exocarp do not separate and the dispersal unit is the entire 4-winged fruit or 4 single-winged, usually 1-seeded, fruitlets.

Within this group there are three new taxa. Two of these, *Z. reticulatum* and *Z. aurantiacum* ssp. *simplicifolium* were recognised by Eichler but they required further study; the last, *Z. halophilum*, was recognised subsequently by the author.

1 Petals less than 5.5 mm long, less than or just exceeding the calyx
- 2 Fruits dispersed as whole, not separating into winged fruitlets
  - 3 Dried fruits with very close subparallel venation on wings .... ***Z. eremaeum***
  - 3: Dried fruits with widely spaced reticulate venation on wings .... ***Z. reticulatum*** p.p.
- 2: Fruits breaking into 4 single-winged fruitlets for dispersal
  - 4 Petals usually shorter than the sepals; style 0.2–0.4 mm long; disc lobes oblong [fruits yellow-green, ?not developing reddish tinge; salt lake margins c. north of Great Eastern Hwy between Southern Cross and Coolgardie, at least as far north as Agnew and Meekatharra] .... ***Z. tetrapterum***
  - 4: Petals longer than the sepals; style 0.6 mm long; disc lobes semicircular [Fruits green, developing red-purple coloration; salt lake margins, Southern Cross to Scaddan and east along Eyre Hwy, W.A., Serpentine Lakes, S.A.] .... ***Z. halophilum***

1: Petals more than 5.5 mm long, exceeding the calyx; style usually more than 1.5 mm long
- 5 Leaflets distinctly articulate with petiole [fruits with widely spaced reticulate venation on wings; coastal areas of W.A.] .... ***Z. fruticulosum***
- 5: Leaflets not articulate with petiole
  - 6 Fruits not separating into fruitlets, with widely spaced reticulate venation on wings when dry .... ***Z. reticulatum*** p.p.
  - 6: Fruits separating into fruitlets, with closely spaced more or less parallel venation on wings when dry
    - 7 Leaves lacking either petiole or leaflets, subterete
      - 8 Leaves sessile or subsessile, apparently in whorls of 4 at each node .... ***Z. aurantiacum*** ssp. ***verticillatum***
      - 8: Leaves simple, lacking leaflets or only very shortly lobed at apex, paired at each node .... ***Z. aurantiacum*** ssp. ***simplicifolium***
    - 7: Leaves with distinct petioles and leaflets, flat
      - 9 Leaflets narrow-oblong to linear, about as long as the linear petiole .... ***Z. aurantiacum*** ssp. ***aurantiacum***
      - 9: Leaflets broad, much shorter than the cuneate petiole into which they are gradually narrowed .... ***Z. aurantiacum*** ssp. ***cuneatum***

Zygophyllum halophilum R.M. Barker, sp. nov.

Species nova *Z. tetraptero* proxima sed differt stylibus longioribus, petalis sepalis longioribus et nectario semicirculari.

Holotype: *R.M. Barker 1269*, 14.ix.1995, Western Australia, Coolgardie Esperance Hwy, 13.5 km NW of Norseman by road. Common. Edge of salt lake with samphire. Small erect or decumbent herb with reddish stems below. Leaves non-articulate, Y-shaped, fleshy. Flowers yellow, just exceeding sepals, turning white. Fruits 4-winged, green, pendent, often with reddish flush. (AD); *isotypes:* PERTH, CANB – yet to be distributed.

Z. tetrapterum auct. non Hj. Eichler ex R.M. Barker: R.M. Barker, *J.Adelaide Bot. Gard.* 17: 164 (1996) p.p. (only with respect to *Cranfield s.n.* collection from Bullfinch).

Decumbent, spreading, glabrous, perennial *shrub,* 12–20 cm high, 20–30 cm wide; often with reddish foliage. *Leaves* petiolate; leaflets succulent, oblong, 4–17mm long, 1–2.5 mm wide, continuous with petiole, obtuse-rounded at the apex; petiole 4.5–15 mm long, flattened, similar width to leaflets. *Flowers* single at each node. *Pedicel* 3–4 mm long in flower, erect, 4.5–6 mm long in fruit. *Sepals* 2.3–2.8 mm long. *Petals* yellow, 3–3.7 mm long, longer than sepals. *Stamens* 8; filaments gradually dilated to base, without appendages; anthers 0.5–0.7 mm long. *Disc* 4-lobed; lobes free, semicircular, succulent,

papillose on margin. *Ovary* 4-winged, 4-celled, glabrous, often moderately papillose; style 0.5–0.7 mm long; stigma minute, 4-lobed. *Fruit* 4-winged, pendent, cordate, elliptic with deeply emarginate apex, 7–10 mm long, often purplish in colour, breaking into four 1-celled fruitlets, rounded at apex, with 1 seed per cell; seeds 3.4–3.6 mm long, pale brown, elliptic, finely pitted; fruiting style 0.5–0.7 mm long. Fig. 3 A–D.

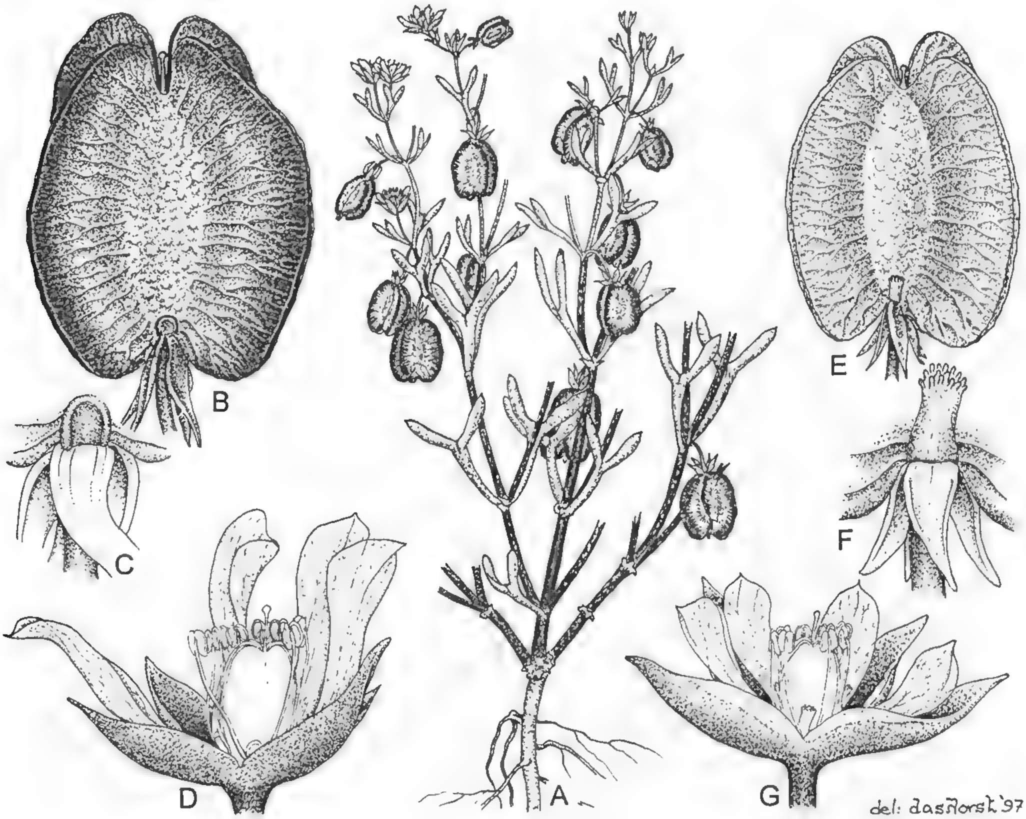

Fig. 3. ***Zygophyllum halophilum*** R.M. Barker. **A,** habit ×0.75; **B,** fruit ×6; **C,** gland ×20; **D,** opened flower ×10 showing petals longer than sepals (**A–D,** *R.M. Barker 1269*); ***Z. tetrapterum*** H. Eichler ex R.M. Barker **E,** fruit ×3.5; disc ×14; **F,** opened flower ×10; **G,** showing petals shorter than sepals (**E–G,** *R.M. Barker 1052*).

Distribution & ecology

Known by collections from the Great Eastern Highway and Coolgardie Esperance Highway between Southern Cross and Scaddan and along the Eyre Highway as far as Balladonia in Western Australia, with outlier collections from Peak Charles and also a single record from Serpentine Lakes in South Australia. It is likely however to occur in the salt lakes throughout these areas. Occurs in or on edges of salt lakes, often with samphires. Flowers August to October.

Notes

Although they are obviously very closely related, *Z. halophilum* can be distinguished from *Z. tetrapterum* H. Eichler ex R.M. Barker by a number of characters,. The semi-circular rather than oblong disc, longer style length and petals longer than the sepals all

serve to distinguish the two taxa. In addition, although further field observations are required, this species may have the capacity to become woody and perennial, and it is possible that the fruits of this species assume a reddish-purple tinge whereas those of *Z. tetrapterum* do not.

The distributions of *Z. tetrapterum* and *Z. halophilum* are distinct except for overlap in the Southern Cross area. The collection *Barker 1240*, which is a mixture of the two species in this area of overlap, indicates that petal length and disc shape differences between the two species are maintained, although the differences in length of the styles in the two taxa is not really distinct. It is also from this collection that the very marked difference in development of reddish colour in the fruit of *Z. halophilum* compared to its absence in *Z. tetrapterum* was first noted; the rest of the herbarium collections would seem to support this but field observations are required. Because of the maintenance of these differences in an area of overlap the two have been treated as species rather than at an infraspecific level.

Specimens examined

AUSTRALIA. WESTERN AUSTRALIA: *R.M. Barker 1240 p.p.*, 13.ix.1995, Great Eastern Hwy, eastern outskirts of Southern Cross (AD); *R.M. Barker 1275*, 15.ix.1995, Eyre Hwy, 36 km E of Norseman (AD); *M.A. Burgman 3680*, 14 km due south of Peak Charles, 9.54 km S of Peak Charles Road on Fields Road (PERTH); *R.J. Cranfield s.n.*, Bullfinch (PERTH); *Hj.Eichler21250bis*, 13.ix.1971, At the edge of a salt lake immediately NW of Norseman (CANB); *Hj.Eichler21288B*, 14.ix.1971, c. 84 km by road from Norseman towards Balladonia along the Eyre Hwy (AD, CANB); *Hj.Eichler22964*, 8.ix.1982, E edge of Lake Cowan, c. 1 km W of Norseman, just E of airport runway (CANB, PERTH); *Hj.Eichler22968*, 8.ix.1982, At the E end of Lake Cowan, c 3 km N of Norseman at the W side of Eyre Hwy (CANB, PERTH); *Hj.Eichler22970*, 8.ix.1982, SW of Lake Lefroy, c. 6 km N of Widgiemooltha, at the edge of the salt lake E of Eyre Hwy (CANB, MEL, PERTH); *Hj.Eichler23151*, 5.x.1982, C. 3 km N of Norseman at the W side of Eyre Hwy (CANB); *Hj.Eichler23153*, 6.x.1982, C. 5 km NNW of Norseman, near the beginning of the causeway through Lake Cowan (CANB); *P. van der Moezel 132*, 21 km NE of Scaddan (PERTH); *K. Newbey 5170*, Lake Bryde Reserve (PERTH).

SOUTH AUSTRALIA: *D.E. Symon 012575*, 25.viii.1980, Connie Sue Hwy, adjacent to Serpentine Lakes (AD, B, CANB).

Zygophyllum reticulatum H. Eichler ex R.M. Barker, sp. nov.

Species nova proxima *Z. fruticuloso* sed differt foliolis non articulatis.

Holotype: R.M. Barker 1260, 14.ix.1995, Western Australia, Boulder-Kambalda Rd, 16.8 km from Boulder P.O. (AD); *isotypes:* 4 to be distributed.

Glabrous, annual *herbs*, 25–40 cm high and 30–40 cm wide or *shrubs,* climbing or sprawling in other vegetation and up to 2 m high. *Leaves* petiolate; leaflets succulent, narrowly oblong, 4.5–12(-25) mm long, 0.9–1.5(-2) mm wide, continuous with petiole, acute at the apex; petiole 3–8(-12) mm long, flattened, similar width to leaflets. *Flowers* single at each node. *Pedicel* 2.5–3.5(-7) mm long in flower, erect, 3.5–7(-9.5) mm long in fruit. *Sepals* 4, 3–4.5 mm long, often red or purple. *Petals* 4, yellow, fading white, obovate, usually distinctly clawed, 3.3–5(-6.2) mm long, longer than sepals. *Stamens* 8; filaments 2.2–2.5(-3.7) mm long, gradually dilated to base, not winged, without appendages; anthers 0.5–0.9 mm long. *Disc* 4-lobed; lobes free, semicircular, succulent, papillose on margin. *Ovary* 4-angled, 4-celled, glabrous; stigma usually distinctly 4-lobed, rarely entire. *Fruit* 4-winged, green, sometimes with reddish edges, pendent, +/- circular to transversely elliptic, 11–15 mm long, 7.5–22mm broad, not breaking into single winged samaras, 4-celled, rounded or truncate with shallowly emarginate apex, with 0–1 seeds per cell (1(-2) per fruit); wings of dried fruits with a clear, widely spaced reticulate venation. Seeds mostly immature, c. 5 mm long, pale brown with hygroscopic hairs all over; fruiting style 0.4–2 mm long, usually red. Illustration of leaf and fruit in Barker 1996, Fig. 3. Fig. 4A–D.

Distribution & ecology

Distribution is problematic. Mainly recorded from an area east of Wiluna and from the Kalgoorlie area, with a few collections from the Nullarbor Plain and a number from the Port Augusta area in South Australia. Minimal ecological information is noted but the species is recorded from mallee and spinifex in red sand over limestone. Flowers August-October.

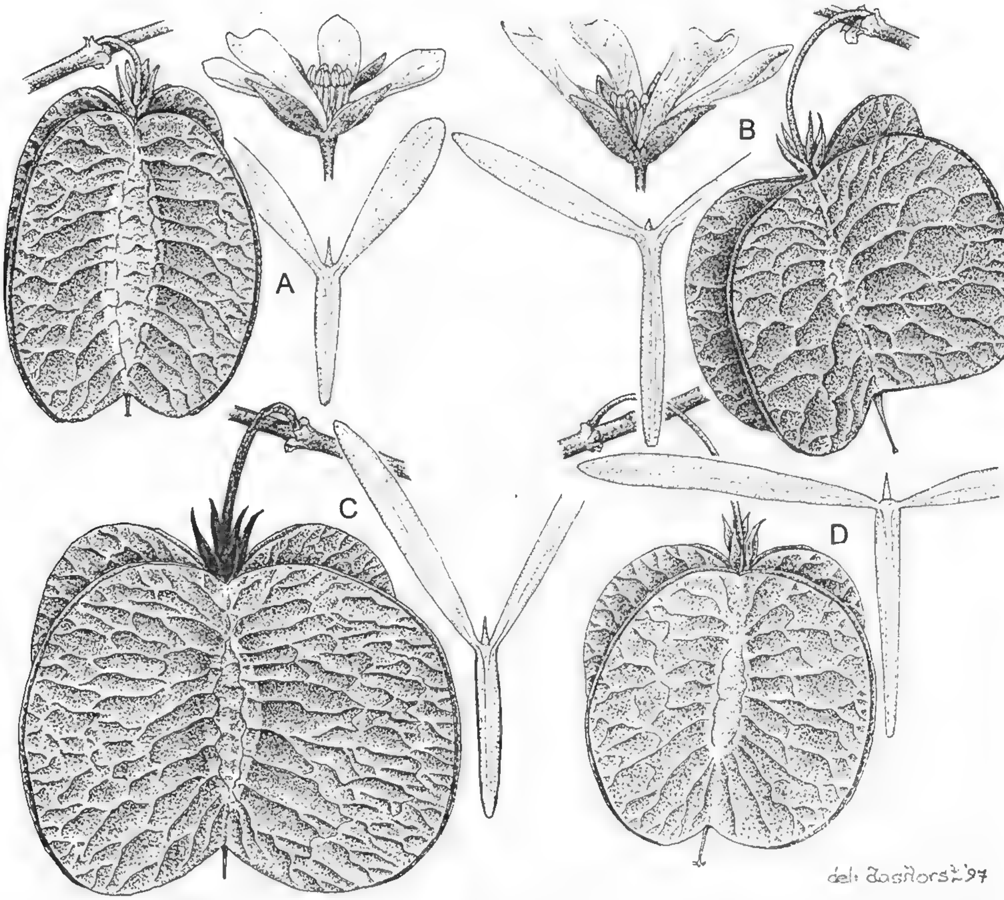

Fig. 4. Variation in ***Zygophyllum reticulatum*** H. Eichler ex R.M. Barker. **A,** fruit ×2, flower ×6 and leaf ×3.5 (**A,** *P.G. Wilson 7407*, AD, from Wiluna area); **B,** fruit ×3.5, flower ×6 and leaf ×2 (**B,** *P.G. Wilson 7207*, PERTH, from Menzies/Coolgardie area); **C,** fruit ×4 and leaf ×3.5 (**C,** *R.M. Barker 1266*, AD, from Kalgoorlie); **D,** fruit ×2.5 and leaf ×3 (**D,** *R.M. Barker 1306*, AD, from Port Augusta area).

Notes

This species was first recognised by Eichler but it was not published in the earlier paper (Barker 1996) because the taxonomy was not clear cut. It is clearly related to *Z. fruticulosum* which occurs along the coast of Western Australia, but the leaflets in *Z. reticulatum* are continuous with the petiole rather than clearly articulated as in *Z. fruticulosum*. The species is still in need of further work and extra collections and field observations may help to clarify the relationships of what are possibly a number of infraspecific taxa. All of the specimens seen were segregated into entities. Even though my

own subsequent collections have eroded these entities somewhat, they have been maintained here since they indicate the characteristics which differentiate the populations.

Specimens segregated by Eichler as this taxon bear the annotation "Zygophyllum sp. (aff. Z. fruticulosum DC.)".

Identification of *Z. reticulatum* is difficult in the field since dry fruit need to be present to see the characteristic (see Fig. 4) widely spaced, reticulate venation on the wings of the fruit. If this cannot be seen, then it is difficult to separate this species from the *Z. aurantiacum/Z. eremaeum* group which have similar fruits and leaves. My own collections from the Kalgoorlie/Norseman area (*Barker 1255, 1260, 1264, 1266*), were all segregated in the field as *Z. reticulatum* even though this reticulate venation pattern was not discernible. These specimens were all sprawling shrubs of a distinctive green with noticeably red buds and calyces, a reddish tinge on the outer wings of the fruit and the fruits topped by a small red style and stigma. However my other collection of this species from the Whyalla area (*Barker 1305*) was given a field identification of *Z. aurantiacum* and did not share the red calyces of the other collections. In this case the leaves were almost T-shaped, in line with an observation by Eichler for this species. However the character of T-shaped leaves seems to be mainly confined to collections from the Port Augusta area and is not characteristic of the whole species as delineated here.

In short, the characteristics of habit, leaf shape, calyx colour, flower size, style length, stigma division and fruit shape are all variable within this species and require further investigation.

Despite the number of fruits present on most specimens, mature seeds were rarely found, suggesting that the floral biology needs to be looked at more closely. Such observations may also lead to an explanation for the variation in a number of other characters already discussed.

Etymology

The epithet "reticulatum" was used by Eichler and refers to the diagnostic reticulate pattern of the venation in the fruit.

Specimens examined (separated into entities which have no taxonomic standing).

Spreading herbs; petals c. 3 mm long; style 0.4–0.5 mm long, fruits longer than wide; from **east of Wiluna**

AUSTRALIA. WESTERN AUSTRALIA: *A.S. George 5519*, 26.vii.1963, 14 miles E of Carnegie (PERTH); *P.G. Wilson 7407*, 28.viii.1968, c. 200 km N of Laverton (AD,PERTH); *P.G. Wilson 11965*, 6.ix.1984, 6 km E of Yelma HS (PERTH).

Scrambler or climber, fruits wider than long:

- styles 1.5–2 mm long, **Menzies/Coolgardie area**

WESTERN AUSTRALIA: *A.C. Beauglehole 13248*, 19.ix.1965, c. 80 km S of Coolgardie, near road to Norseman (AD); *T.E.H. Aplin 2310*, 17.viii.1963, 10 miles s of Leonora (PERTH); *P.G. Wilson 7207*, 19 km N of Menzies (AD, PERTH).

- styles c. 0.8–1 mm long, **Kalgoorlie area**

WESTERN AUSTRALIA: *R.M. Barker 1255*, 14.ix.1995, Kalgoorlie outskirts, Great Eastern Hwy (AD); *R.M. Barker 1266*, 14.ix.1995, Kambalda – Norseman Rd, 18.3 km SW of junction of Kambalda-Boulder and Kambalda-Norseman Rd (AD); *A.C. Beauglehole 13349*, 21.ix.1965, 9 miles N of Norseman on Coolgardie Rd (PERTH); *W.D. Campbell [Herb. Morrison]*, 22.viii.1900, Mt Hunt, Kalgoorlie (PERTH); *W.D. Campbell*, 22.viii.1900, Mt Hunt, Kalgoorlie (PERTH); *W.D. Campbell [Herb. Morrison 338]*, 22.viii.1900, Mt Hunt, Kalgoorlie (PERTH ex K); *W.D. Campbell s.n.*, 21.ix.1900, Boulder and 22.viii.1900, Mt Hunt (PERTH); *W.D. Campbell s.n., viii.*1900, Boulder (PERTH); *M.E. Phillips s.n.*, 13.ix.1962, 4 miles N of Kalgoorlie (CANB); *P.*

Wilson 2870, 9.ix.1964, 16 km s of Balladonia (AD); *P.G. Wilson 7508*, 30.viii.1968, 5 km NE of Kalgoorlie (PERTH 02413140).

Climber to 2m high or sprawler or spreading shrub, 40 × 40 cm; style 4-lobed at apex; fruits +/- circular. **From Norseman, across the Nullarbor Plain to Port Augusta.**

WESTERN AUSTRALIA: *G.J. Keighery & J.J. Alford 576*, 18.x.1986, 41 km N of Trans-line on western boundary fence of Kananda Station (Nullarbor Plain) (PERTH); *K. Newbey 6919*, 30 km ESE of Sinclair Soak, c. 75 km NE of Norseman (PERTH,2 sheets); *K. Newbey7525*, 21.ix.1980, 19 km ENE of Norseman (PERTH).

SOUTH AUSTRALIA: *R.M. Barker 1305*, 20.ix.1995, Lincoln Hwy, c. 31 km N of Whyalla (AD); *E.M. Canning s.n.*, 28.viii.1968, 6.4 km from Whyalla, towards Cowell, along Lincoln Hwy (AD97429101); *J.B. Cleland s.n.*, 19.vii.1943, Port Augusta (AD96247067, AD96247043); *R.J. & S. Chinnock 1411*, Redcliff Petrochemical area, 25 km SE of Port Augusta (AD, G, H, PH, PRE, TI, US); *R.D. Royce 5499*, 20.ix.1956, Jumnania Rocks, NE of Karowie on Transcontinental Rlwy (PERTH); *S.A. Pastoral Board s.n.*, 5.vii.1956, Euria Well and Rockhole, c. 55 km NE of Fowlers Bay (AD97914155); *D.E. Symon 485*, 12.vi.1960, From the Flinders Nursery (W. Hancock), Port Augusta (AD).

Zygophyllum aurantiacum (Lindley) F. Muell., *Linnaea* 25: 376 (Feb. 1853).

Basionym: *Roepera aurantiaca* Lindley, *Bot. Reg.* 24 (Aug. 1838) Misc. p. 57 No. 105; Lindley in Mitchell, Three Expeditions into the interior of Eastern Australia 2: 70 (Aug.-Sept.1838); *Zygophyllum fruticulosum* var. *bilobum* Benth., *Fl. Austral.* 1: 294 (1863).

Lectotype here designated: *Major Mitchell's Expedition 182[3]6*, 11 May [1836], Without specific locality [Interior of New Holland, Lachlan River, New South Wales] (CGE p.p.); *probable isolectotype*: *Mitchell's journey 142*, 11 May [1836], Without locality (MEL, possibly p.p.); *other syntype: Anon. [Mitchell per Lindley] s.n.*, s.dat., HHS [Horticultural Society, London] (CGEp.p.).

Typification

1. Type citation

   Lindley wrote in the *Botanical Register* as follows "It was found by Major Mitchell in his latest journey into the interior of New Holland, and was raised in the garden of the Horticultural Society, where it flowers in the open border in July..." while Mitchell wrote in his account of "a fine hard plain, covered very generally with small bushes of a beautiful orange-flowered spreading under-shrub, with broad thin-winged fruits". The locality was on the Lachlan River on its approach to the Murrumbidgee with the latitude for the previous day given as 34°14'37"S and longitude 144°25'E.

2. The date of publication

   There seems little doubt that Lindley's account of this species, which he cited as "Roepera aurantiaca Lindley in Major Mitchell's Australia, ined", in the *Botanical Register* preceded the publication in Mitchell's account of his journeys, as has already been pointed out in Barker & Barker (1990) and apparently accepted by Eichler in his manuscripts. The description is sufficient for formal publication of the species.

3. Specimens to be considered as types

   Obviously Mitchell's collections are type material but so also is the material grown from seeds of the Mitchell collection at the Horticultural Society in London, since this is referred to by Lindley in the protologue. This is also referred to in the second edition of Mitchell's account of his journeys (Mitchell 1839) where an additional footnote has been added under the description of *Roepera aurantiaca*. This is dated Nov. 1838 and reads "This Ro[e]pera has grown in the garden of the Horticultural Society at Chiswick, and proves a pretty new annual flower". Lindley was at this time Professor of Botany at London University but continued to hold office in the Royal Horticultural Society whose gardens were at Chiswick, and it is no doubt to him that the collection from there should be attributed. It is mounted together with Mitchell's collection on the sheet in

Cambridge, the chief repository of Lindley's herbarium. A Mitchell collection in MEL is numbered 142 and is almost certainly a duplicate of the material in the Lindley herbarium. Unfortunately the photograph of the Cambridge type in the Eichler manuscripts does not include the whole of the Mitchell label and it is unknown whether it too bears this number.

4. Selection of type

   Mitchell's collection in Lindley's herbarium in Cambridge has been chosen as the lectotype since it is the only one to have been annotated by Lindley with his characteristic "R. aurantiaca m."

Another new subspecies of *Z. aurantiacum*

Two new subspecies of *Z. aurantiacum*, ssp. *verticillatum* H. Eichler ex R.M. Barker and ssp. *cuneatum* H. Eichler ex R.M. Barker, segregated, but not published, by Hansjoerg Eichler, were described in an earlier paper (Barker 1996). Within this paper was a reference to a further taxon known as Z. "simplicifolium" which was included in the illustration (fig. 1A) of the leaf variation of the *Z. aurantiacum* complex. Z. "simplicifolium" was not formalised at that stage since it had not been treated in any of the keys, was not separated as a distinct taxon within the Eichler manuscripts, and there were few collections which had been annotated by Eichler. Nor had a type been segregated in either AD or CANB as they had for other manuscript taxa. The subspecies is formalised here.

There has been no opportunity as yet, for the author to make field studies of the subspecies of *Z. aurantiacum*, but it is known that ssp. *cuneatum* and the following subspecies are to be found in gypsiferous or limestone areas, ssp. *verticillatum* is usually to be found on rocky slopes or stony tablelands, while the more widely distributed ssp. *aurantiacum* is less discriminating in its requirements and found within sandy soils in mallee communities. Where the subspecies overlap, as with ssp. *auranticaum* and ssp. *cuneatum* in the Dulkaninna region, the leaf differences are apparently maintained (H. Vonow, pers. comm April 1997).

Zygophyllum aurantiacum **ssp.** ***simplicifolium*** H. Eichler ex R.M. Barker, ssp. nov.

[Zygophyllum simplicifolium H.Eichler MS on occasional herbarium specimens.]

Subspecies nova *Z. aurantico* ssp. *aurantico* proxima sed differt foliis simplicibus indivisis.

Holotype: Hj. Eichler 23172, 9.x.1972, South Australia, 5 km SE of Wudinna, above the shores of the salt lake on the SW side of Eyre Hwy towards Kyancutta. 35° 05'S 135° 30'E (CANB); isotypes: AD, CHR, L, MO (still to be distributed).

Z. fruticulosum DC. var. *brevilobum* J.M. Black, *Trans.Roy.Soc. S. Austral.* 54: 60 (1930).

Holotype: J.B. Cleland s.n., 30 Oct. 1929, Seventeen miles N of Tarcoola (AD97918161).

Low and spreading or upright and rounded, glabrous, perennial *shrub*, 30–100 cm high, wider than high. *Leaves* simple (petiolate only), linear, subterete, 12–40 mm long, 0.8–1.7 mm wide, rounded, truncate or emarginate at apex, sometimes with very short lobes (less than 5 mm long).

Distribution & ecology

Simpson Desert of Northern Territory and South Australia, Nullarbor to Gawler Ranges and north western Eyre Peninsula. Occurs on slopes of sand dunes at edges of salt lakes, usually in highly gypsiferous areas. Flowering July-September.

Notes

An illustration of the leaves of this subspecies is to be found in fig 1A of R.M. Barker (1996). The leaves have been described as simple in this case and in line with the terminology used in the other three subspecies, are described as consisting of petiole only. Thus the undivided part of the "leaf" is described as petiole and above the division as leaflets. Anatomically this is probably not correct, but the concept has been consistently used throughout this treatment of *Zygophyllum* for Australia.

The epithet is attributed to Eichler even though there seems to be very little material bearing this name and its origin is a little more obscure than are Eichler's epithets for other taxa. The name was certainly in use within the State Herbarium of South Australia but rather surprisingly it does not appear on AD or CANB specimens. These are more likely to be annotated as Z. "aff. aurantiacum (simple leaves)" as on *Purdie 2845* in CANB, or to have no annotation at all. The epithet may have been used on material in other herbaria.

The type of *Z. fruticulosum* var. *brevilobum* J.M. Black, falls within this taxon. It belongs with a group of specimens assigned to ssp. *simplicifolium* in which the division of the lobes apically is somewhat deeper than that usually encountered and for which the epithet "brevilobum" is particularly appropriate. Other specimens, of those listed below, which share this characteristic are *Chinnock 2722, Kraehenbuehl 3638, Whibley 707, Weber 6750, Phillips s.n.* and *Eichler 21364,* all from the Tarcoola, Penong, Gawler Range and Nullarbor region of South Australia. Thus the more deeply lobed leaves are all from the western end of the distribution of ssp. *simplicifolium.* A few of the leaves on the Whibley specimen are as deeply divided as those in ssp. *aurantiacum.*

Etymology

The epithet simplicifolium is derived from simplici-, Latin for simple or undivided and folium, Latin for leaf, and is a reference to the undivided leaves of this species.

Specimens examined:

NORTHERN TERRITORY: *G. Leach 1486,* Kilpattha Native Well, Simpson Desert (AD, DNA).

SOUTH AUSTRALIA: *S. Barker 70 & Fatchen,* 1.viii.1972, Surprise Lagoon (AD); *R.J. Chinnock 2722,* 2.x.1975, Ifould Lake (AD); *P.E. Conrick 2187,* Poeppel Corner (AD, SYD, RSA); *Hj. Eichler 21364,* 16.ix.1971, Point Sinclair, on N side of causeway towards Penong (AD); *Hj. Eichler 23161,* 8.x.1972, Point Sinclair, just after the end of the causeway of road to Penong (AD, CANB, MEL); *Hj. Eichler 23162,* 8.x.1972, Point Sinclair, just before beginning of causeway of road to Penong (AD, CANB, MEL, US, LP); *D. Kraehenbuehl 3638,* 3.ix.1972, along fringes of Ifould Lakes, c. 60 km S of Ooldea (AD); *N.F. Norris 819,* 31.viii.1982, c. 17 km NE of Kingoonya on the 29 km road connecting Kingoonya and the bitumen of the Stuart Hwy (AD); *M.E. Phillips s.n.,* 30.viii.1968, 11 miles from Streaky Bay towards Ceduna (AD, CANB, L); *R.W. Purdie 2845,* 2.viii.1982, Lower slope of sand dune adjacent to salina between Bench Markers 6863 and 6864, c. 49 "dune-km" W of Poeppel Corner, Simpson Desert (AD, CANB); *A.C. Robinson 228,* 7.x.1987, south margin of Pinjarra Lake (AD); *A.M. Rowell 125,* 29.x.1980, 4 km SE Wudinna (CANB); *A.M. Rowell 126,* 29.x.1980, 4 km SE Wudinna (AD, CANB); *A.M. Rowell 128,* 29.x.1980, minor road from Eyre Hwy near wudinna to Elliston, 2 km SW of Hwy (AD, CANB); *D.E.Symon 8205,* Gawler Ranges (AD, CANB, MO); *J.Z. Weber 6750,* 3.ix.1980, c. 30 km S of Kokatha (AD); *D.J. Whibley 707,* 19.ix.1960, Lake Yarle, c. 25 km NNW of Watson (AD); *L.D. Williams 9156,* 19.ii.1977, 28 km NNE of Streaky Bay (AD).

Zygophyllum eremaeum (Diels) Ostenf., *Det Kongelige Danske Videnskabernes Selskab Biologiske Meddeleser* 3(2): 76 (1921), Textfig. 11 b.

Basionym: Zygophyllum fruticulosum var. *eremaeum* Diels in Diels & Pritzel, *Bot. Jahrb.* 35: 315 (1904); – *Zygophyllum aurantiacum* var. *eremaeum* (Diels) H. Eichler, *Taxon* 12: 297 (1963).

Type citation: Forma per Eremaeam divulgata in distr. Austin pr. Murrinmurrin flor. et fruct. (W.J. GEORGE in hb. Berl.); in distr. Coolgardie pr. Kalgoorlie in arenosis parce fruct. m. Nov. (D. 1684).

Syntypes: W.J. George s.n., s.dat., [Western Australia], Austin district, near Murrinmurrin (B, n.v.); *L.Diels 1684,* Nov., [Western Australia], Coolgardie district, near Kalgoorlie (B, n.v.).

Notes

1. Flowers in this species (and perhaps in other species of *Zygophyllum* as the following phenomenon has been observed in other species) are in need of further study. Within the just opened calyx can be found flowers in which the style surpasses the very short corolla lobes which are themselves appressed to the ovary, as are the very short and unopened stamens. Cleistogamy was the first thought to explain these flowers, particularly as the number of fruits set in this species seems to be more than in other species, but the apparently intact stamens well below the raised style rules this out. The stamens do eventually occur at the same level as the stigma and therefore the apparently large numbers of fruit may be because this species is self-compatible.

2. A group of specimens, some of them labelled as "Zygophyllum aff. eremaeum - annual form", need closer investigation. They may be either first year plants of this species or a distinct taxon. Although very floriferous, none of them possess mature fruits and the young fruits tend to be longer than wide and the styles consistently 0.6 mm long, i.e. somewhat shorter than is usual for this species. Because of their locality, these specimens may relate to the manuscript name "Z. kalgoorliensis" within the Eichler manuscripts, but no description, discussion or specimens annotated with this name have been found.

WESTERN AUSTRALIA: *A.C. Beauglehole 60058 & E.G. Errey 3758,* 276 km by road NE of Laverton-Warburton road, Great Victoria Desert (PERTH); *A.S. George 4155,* 34 miles N of Kalgoorlie (PERTH);); *J. Dell 32,* 8.7 km ENE of Yuinmery Homestead (PERTH).

3. There are some very woody specimens, leafless in the basal parts and with reduced flowers, from Kalgoorlie and areas inland from there. These may be older specimens or a result of exposure to harsh conditions.

WESTERN AUSTRALIA: *B. Nordenstam & A. Anderberg 611,* 20 km N of Kalgoorlie (PERTH,S); *M.D. Crisp 5827, J. Taylor & R. Jackson,* c. 35 km W of Plumridge Lakes, 8.5 km WNW of Salt Lake airstrip (CBG, PERTH).

Z. marliesiae, a new species close to *Z. prismatothecum*

Zygophyllum marliesiae R.M. Barker, sp. nov.

Species nova affinis *Z. prismatotheco* sed differt fructibus rotundatibus, appendicibus brevioribus apicalibus, destitutis sulcis longitudinalis et destitutis vel papillis sparsis albis in faciebus.

Holotype: F.J. Badman 1389, 30.vii.1984, South Australia, 10 km NW of Warrina, 110 km NNW of William Creek. Common. On brown soil ridge between Edward Creek and sandhill. Spreading habit. succulent leaves. Flowers yellow. (AD); isotypes: CANB, MEL.

Zygophyllum "Lake Eyre" (K. Chorney 999), R.M. Barker MS name on AD specimens.

Spreading, glabrous, annual to 15 cm high, wider than high. *Leaves* petiolate, with 2 pairs of leaflets; leaflets succulent, elliptic, 3.5–8 mm long, 2.5–8.5 mm wide, continuous with petiole and not articulated at base, rounded at the apex; petiole flattened, 4.5–9.5 mm long, attenuate, sometimes sub-auriculate. *Pedicel* 0.8–2.5 mm long in flower, 1–2 mm long in fruit. *Sepals* 4, 2.2–3.5 mm long. *Petals* 4, yellow, 1.9–3 mm long, slightly shorter to slightly longer than sepals. *Stamens* 8; filaments winged in lower half, wing not noticeably toothed. *Disc* 4-lobed; lobes free, oblong, succulent, papillose on apex. *Ovary* 4-angled, 4-celled; style 0.2–0.3 mm long; stigma discoid, not lobed. *Capsule* erect, rounded-oblong, 7–11 mm long, 4-angled, 4-celled, sides continuous into 4 falcate, 0.5–1 mm long, appendages at apex, with (1)2–3 seeds per cell; seeds 2.5–3 mm long, smooth, shining,

ostensibly glabrous but the appressed hairs rapidly taking up water on exposure; fruiting style 0.5–1(-2) mm long. Fig. 5, G–J.

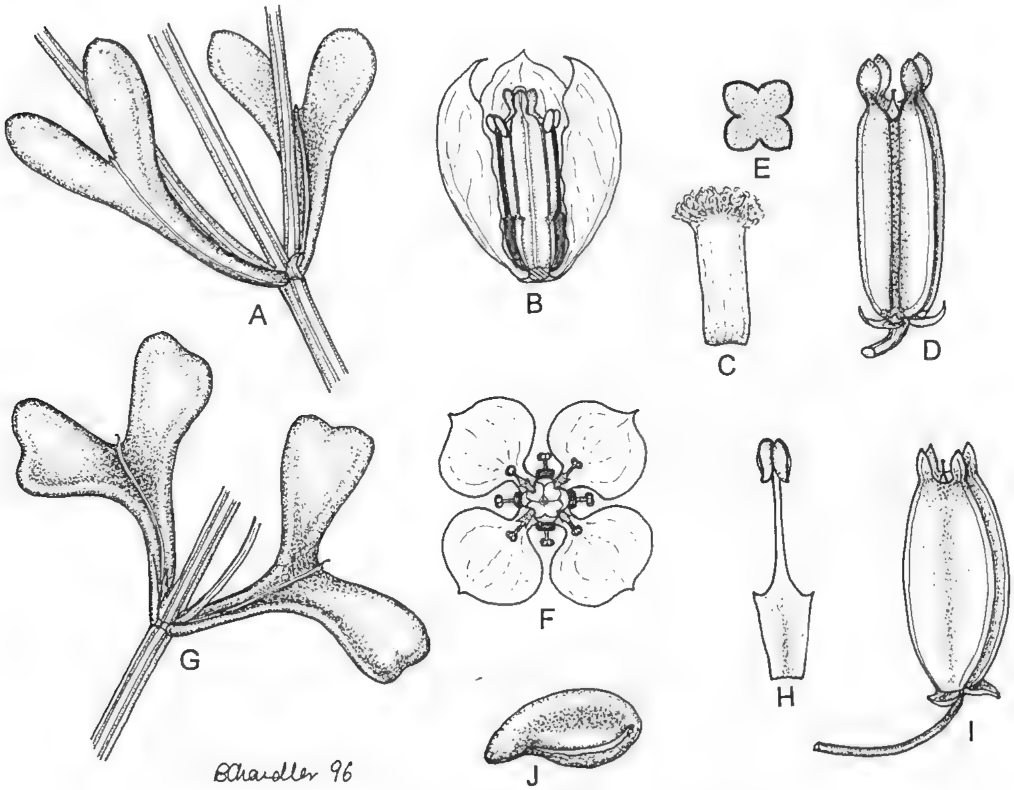

Fig. 5. Comparison of ***Zygophyllum marliesiae*** R.M. Barker and ***Zygophyllum prismatothecum***. **A–E**, ***Zygophyllum prismatothecum***: **A**, pair of leaves ×2 (*J.Z. Weber 2107)*; **B**, cross-section of flower ×10 (*D.J.E. Whibley 2267*); **C**, disc or nectary ×15 (*D.J.E. Whibley 2267*); **D**, fruit ×3 (*J.Z. Weber 2107)*; **E**, cross-section of fruit. **F**, floral diagram applicable to both species; **G–J**, ***Zygophyllum marliesiae***: **G**, pair of leaves ×2; **H**, stamen ×20; **I**, fruit ×3; **J**, seed ×12 (all *K. Chorney 999)*.

Distribution & ecology

Confined to the Lake Eyre region of South Australia, although it does not seem to be confined to a particular ecological niche. It has been recorded from salt pans, from samphire flood plains, from limestone formations associated with mound springs, from gypseous flats and from sand hills.

Notes

1. The white papillae on the fruit almost certainly play a role in the dispersal of *Z. prismatothecum*. Their lack or very much reduced state in *Z. marliesiae* may help to explain the very much reduced area of distribution of this species compared with that of *Z. prismatothecum*.
2. The development of the appendages on the apex of the fruit in *Z. marliesiae* and *Z. prismatothecum* does not impede pollination. In young fruits of both species, the style is

raised above the appendages (these are quite visible even in the young stages) and the stigma is at the same level as the dehiscing anthers, suggesting that self pollination is possible and likely. By maturity the style is invariably shorter than the erect appendages. The style is usually well below the level of the longer appendages in *Z. prismatothecum*, but in *Z. marliesiae* it is usually just less than them. There is variation in the style's length and thickness. The only specimen seen in which the style considerably exceeded the appendages in mature fruit as shown in unpublished illustrations of *Z. prismatothecum* by Ludwig Dutkiewicz and noted by Eichler (1986), is a single plant in a mixed collection of the two species (*Eichler 19673*). In this particular specimen the style is very slender for its whole length, twice the length (i.e. 2 mm long) of that seen in other collections of *Z. marliesiae,* and still held well above the appendages at maturity. The few flowers present on this specimen are far from perfect but they do not appear to differ markedly in character from those found in *Z. marliesiae.* The collection *Badman 1466* also has styles longer than the appendages, but this is because of the shortness of the appendages rather than the style being particularly long. Some understanding of the floral biology of this group is needed before the importance or otherwise of the style length can be assessed.

3. The seeds appear to be glabrous, but on contact with water the appressed hairs on the surface rapidly expand and absorb water. Some reports record such hairs as being mucilaginous but there was little evidence of any stickiness associated with them, i.e. the wet seed did not adhere to surfaces and did not readily attach objects to its surface.

Distinguishing features

Z. marliesiae can be distinguished from the more widely spread *Z. prismatothecum*, with which it overlaps in distribution, predominantly on fruiting characters. It differs by its longer pedicels in flower and fruit, by the elliptic rather than rectangular fruits and by the much shorter apical appendages (0.5–1 mm long cf. 2–3.5 mm long in *Z. prismatothecum*) on the fruit; these appendages are continuous with the angle of the fruit wall and not constricted at their base as in *Z. prismatothecum.* Furthermore, the fruits of *Z. marliesiae* lack a longitudinal groove at the midline of each of the faces of the fruit and the white papillae which occupy this groove in *Z. prismatothecum* are, in *Z. marliesiae*, either lacking completely or confined to a few papillae in a small apical area on each face.

Etymology

Named after Mrs Marlies Eichler. Marlies always shared in Hansjoerg's work, although her contribution is largely unsung. She has continued to very generously support Australian plant taxonomy since Hansjoerg's death.

Specimens examined

AUSTRALIA. SOUTH AUSTRALIA: *F.J. Badman 915,* 9.iv.1984, 23 km SSE of Maree (AD); *F.J. Badman 1466*, 25.viii.1984, 2 km S of Strangways Spring (AD); *R.J. Bates 19251*, 9.vii.1989, William Creek, where road crosses creek (AD); *R.J. Bates 19261*, 9.vii.1989, Flats along the Oodnadatta track, S of Oodnadatta (AD); *A.C. Beauglehole 28113,* 1.viii.1968, 21 miles N of William Creek (AD); *B. Copley 3576,* 3.ix.1971, 1 mile S of Muloorina (AD); *H. Brooks s.n.*, x.1950, shores of Lake Eyre, c. 10 miles from Coopers Creek entrance (AD 96246075); *K. Chorney 999*, 4.x.1978, Beresford Hill (AD); *Hj. Eichler 19673*, 26.x.1967, Flinders Ranges, mouth of Italowie Gorge (ADp.p.); *R.Hill 1158*, 9.ix.1963, c. 0.25 miles of Muloorina HS (AD); *R.H. Kuchel 710*, 7.viii.1963, c. 10 km N of Coward Springs (AD); *R.H. Kuchel 1166,* 11.ix.1963, dunes, c 30 km NW of Muloorina HS (AD); *R.H. Kuchel 2880*, 3.ix.1971, Muloorina Stn HS (AD); *T.R.N. Lothian 1352*, 7.viii.1963, 15 miles N of Anna Creek (AD); *T.R.N. Lothian 4992,* 31.vii.1968, c. 15 km S of Curdimurka (AD); *D.R. Smyth 98*, 1.vii.1966, 2.5 mls W of Strangways Railway Stn, artesiam mound spring (AD); *R. Swinbourne 5156,* 7.ix.1968, Near airstrip, Andamooka Opal Fields (AD); *D.E.Symon 11117*, 1.x.1978, Strangways Springs (AD); *J.Z. Weber 8847*, 6.iii.1983, Just S of Strangways Railway siding (AD); *D.J. Whibley 3998*, 12.ix.1973, Chambers Gorge (AD); *L.D. Williams 6319*, 5.xii.1974, N end of Devils Playground, 9 km SE of Billa Kalina HS (AD).

Typifications & notes

Zygophyllum howittii F. Muell., *Fragm. Phyt. Austral.* 3: 150 (1863).

Lectotype here designated: *Dr. J. Murray [Howitt's expedition] s.n.*, [July, 1862], Sandy country near Wills Creek [Diamantina River near Salmonville, 14 miles upstream from Birdsville, Queensland] (MEL95098); *isolectotypes:* K(herb. Hooker), Kp.p., the latter seen as photographs in the Eichler manuscripts.

Typification

All three type sheets consist of small pieces of plants with mature fruits; the lectotype and the herb. Hooker sheet in K are both annotated by Mueller with the same information. Background information given in square brackets on the collector, Dr J. Murray, who joined Howitt's second expedition as surgeon and plant collector, and the locality of the type, was obtained from Willis (1962).

Zygophyllum prismatothecum F. Muell., *Linnaea* 25: 375 (1853).

Type citation: Ad clivos siccos amnis Arkaba.

Lectotype here designated: *F. Mueller s.n.*, Oct. 1851, [South Australia], Akaba, ad clivos siccos (MEL95365); *probable isolectotype*: *F. Mueller s.n.*, s.dat., S. Australia (K); *possible isolectotype*: *F. Mueller s.n.*, s.dat., N.Holl.austr. interior (MEL110964, MEL110969, both herb. Sonder).

Zygophyllum compressum J.M. Black, *Flora of South Australia* 2: 333 (Jun. 1924); J.M. Black, *Trans. & Proc. Roy. Soc. South Australia* 48: 256 (Dec.1924).

Type citation: From Port Augusta westward to near Fowler's Bay, and northward to Far North. Most of the year. - Central Australia.

Lectotype here designated: Anon.[Herb. J.M. Black] s.n., 28.ix.1920, [South Australia], Port Augusta West (AD97918162 p.p.); *isolectotypes:* AD97918163 p.p., K, MEL95437; *syntypes: S.A. White s.n.*, 11.viii.1913, [South Australia], Dalhousie Springs (AD97918163 p.p., AD97918162 p.p.); *R.Helms s.n.*, 5.v.1891, Cootanoorinna (AD97918163 p.p); *Anon.[Herb. J.M. Black] s.n.*, s.dat., [South Australia], Port Augusta (AD97918163 p.p); *Anon [Herb. J.M. Black] s.n.*, 28.vii.1909, [South Australia], Nr Port Augusta (AD97918162 p.p.).

Typification

As with many J.M. Black collections, there is not just one specimen on the type sheet, but a number of collections intermixed with Black's illustrations and notes. There are two such sheets in AD which qualify for type status. The type sheet numbered AD97918163 consists of the following collections.

1. Cootanoorinna, 5.v.1891, *R. Helms s.n.* A flower with Black's detailed drawings of it.
2. Port Augusta West, 28.ix.1920, *Anon.* [*Herb. J.M. Black*] *s.n.* A flower and seeds with Black's detailed drawings.
3. Port Augusta, s.dat., *Anon.* [*Herb. J.M. Black*] *s.n.* Ovary with Black's detailed drawings.

   Dalhousie Springs, 11.viii.1913, *S.A. White s.n.* Major specimen on sheet.

Type sheet numbered AD97918162 consists of the following collections

1. Dalhousie Springs, 11.viii.1913, *S.A White s.n.* One of three specimens on sheet, mounted with drawing and Black's notes.
2. Port Augusta West, 28.ix.1920, *Anon.[Herb. J.M. Black] s.n.* Specimen only.
3. Nr Port Augusta, 28.vii.1909, *Anon [Herb.J.M. Black] s.n.* Specimen only.

In view of the type citation it would be preferable to treat the whole of the two sheets as the holotype, but one specimen has to be chosen as lectotype. Since the collection from Port Augusta West is to be found on both sheets, and has also been sent to K and MEL, it has been chosen as the representative collection; the collection on AD97918162 has been designated as the lectotype. It consists of a small branch with fruits, as do the specimens in K and MEL.

Zygophyllum crassissimum Ising, *Trans. Royal Soc. S. Austral.* 81: 167 (1958), figs 10–14.

Holotype: *E.H. Ising. 3746*, 7.x.1954, South Australia, Evelyn Downs, about 90 miles by road south-west of Oodnadatta (AD95736042); *isotype*: AD95736043. There are a number of paratypes, all collected by Ising and from the same locality: *Ising 3654* (K); *Ising 3655* (AD); *Ising 3838* (NSW,MEL); *Ising 3938–3941* (AD).

Typification

There are two type sheets in AD, not one, as indicated in the protologue. Both consist of three robust branches, and both sheets have flowers and fruits present. It is presumed that the unmounted material as a whole was probably treated as holotype by Ising but when it came to be mounted there was too much for a single sheet. The sheet designated as the holotype corresponds with the protologue numbering and has mounted on it the original notes of Ising. The second sheet has been designated as an isotype, and has only a typewritten AD label on it.

Notes

Bright orange flowered specimens, referred to by Eichler in his manuscript as Z. "chinnockii" belong here. There seems to be no other character to separate them from the more normally yellow-flowered *Z. crassissimum.* Field observations are required to determine what causes this colour variation and whether both colours occur within a population.

Relationship of Z. glaucum and Z. crassissimum

Although closely related, *Z. glaucum* can be distinguished from *Z. crassissimum* by several features.

1. The disc is continuous, thin and shallowly sinuate compared with the discontinuous, 4-lobed, thick and deeply inverse U-shaped disc of *Z. crassissimum*. However the two conditions are not always easily distinguishable. There are often 8 sinuations in the disk of *Z. glaucum* which correspond to the insertion of the filaments.
2. Sepals are very quickly reflexed in fruit in *Z. glaucum*, while apparently (at least in dried specimens) continuing erect for some time in *Z. crassissimum.*
3. Leaflet are often more distinctly glaucous in *Z. crassissimum.*
4. Filament wings are apically toothed, acute or truncate in *Z. glaucum,* truncate in *Z. crassisimum.*

5. *Z. glaucum* is distributed across southern Australia from Coolgardie through to the Murray River area while *Z. crassissimum* occupies a more northerly distribution from the Lake Eyre region in South Australia through to Lake Mackay on the Western Australian/Northern Territory border.
6. *Z. glaucum* is a sprawling herb up to 30 cm high and not particularly woody in its habit while *Z. crassissimum* is an erect or rounded shrub, up to a metre high and wide.

Zygophyllum glaucum F. Muell., *Linnaea* 25: 376 (1853) nomen nudum; F. Muell., *Trans. Proc. Vict. Inst.* 29 (10 Sep. 1855). Non *Z. glaucum* E. Meyer ex Drège, *Zwei Pflanzengeogr.Docum* 230 (1843-44), nomen nudum; E. Meyer ex Sonder in Harvey & Sonder, *Fl.Cap.* 1: 362 (1860) = *Z. sonderi* H. Eichler, *Taxon* 12: 297 (1963).

Type citation: In the Desert along the Murray, Wimmera and Avoca; on St. Vincent's Gulf, Spencer's Gulf, and in various other places in South Australia.

Lectotype here designated: F. Mueller s.n., Nov. 1851, [South Australia], Flinders Range & Spencers Gulph (MEL95036) annotated *Z. glaucum* and *Z. glaucescens*, seen by Bentham, with a number of fruit and with an entire disc; *other syntypes*: *Anon. [F. Mueller] s.n.*, s.dat., [South Australia], Crystal Brook (MEL110966, herb.Sonder); *Anon. s.n.*, s.dat., [South Australia], St Vincents Gulf (MEL95035). Probable syntypes: *F. Mueller s.n.*, late Feb. 1847, [South Australia], Murray scrub (MEL95033) - this has subsequently been mounted separately from the material on MEL95034 with which it was originally associated; *F. Mueller 77*, 15 April 1848, [South Australia], Bethanien (MEL95034) - material is sterile and has been annotated by Mueller as *Z. glaucescens*.

Zygophyllum glaucescens F. Muell., *Plants Indigenous to the Colony of Victoria* 1: 228 (1862), nom. nov., superfluous name. Basionym: *Zygophyllum glaucum* F. Muell. (1855) non E.Meyer ex Sonder (1860).

Typification

The lectotype chosen is one of only two amongst the syntypes to have fruits present. The St Vincent's Gulf collection (MEL95035) is the other. Of these, the lectotype is by far the better material. It was initially annotated as *Z. glaucum* by Mueller but the 'glaucum' has been overwritten by 'glaucescens'. No flowers are present on any of the specimens and they were not described in the protologue; thus the syntypes cannot be placed with respect to the possible taxa discussed below. However Mueller's next description of the species in *Plants Indigenous to the Colony of Victoria,* where he changed the epithet to "glaucescens", clearly described the stamens as "scale cuneate, half as long as the filament, acutely bidentate at the apex, teethless at the sides". He also cited most of the types referred to in the protologue in the distribution statement for this species ("In the subsaline desert-plains along the Murray River, the Wimmera, and the Avoca; in South Australia on the foot of the Barossa Ranges, on St. Vincent's and Spencer's Gulf, and on Venus Bay.......") and so the typical taxon would be the eastern taxon.

Mueller first mentioned the name *Z. glaucum* in *Linnaea* in 1853, but there was no accompanying description and it was not formally published until 1855. Mueller also annotated specimens with his manuscript name 'Roepera zygophylloides'; both names appear in his hand on the syntype which he sent to Sonder.

Notes

Z. glaucum possibly consists of two taxa, separable chiefly on the morphology of the wing of the filament. The two taxa occur across southern Australia, meeting on Eyre Peninsula in South Australia, where both wing types occur, but the taxa still remain as separate entities. Plants from the eastern part of the distribution apparently have wings

which are apiculate either side of the attachment of the filament while those from the west have entire or slightly toothed wings which are either truncate at their apex or more usually, acute (i.e widened at base and then obliquely approaching filament on either side). The lectotype belongs with the eastern specimens as discussed above. These taxa have not been formalised because the author has not studied all of the available material.

Zygophyllum ovatum Ewart & J.R. White, *J. & Proc. Royal Soc. N. S. Wales* 42: 197 (1908), pl.36.

Lectotype here designated: M. Koch 1674, Sept. 1905, Watheroo rabbit fence, W.A. (MEL568254); *isolectotypes*: NSW, PERTH(specimen dated Sept. 1905 on handwritten label, see typification); *probable syntype* (not cited in protologue but annotated by authors and labelled as cotype): *M. Koch 1213*, August 1904, Cowcowing (MEL 1517068); *isolectotype or probable syntype: M. Koch 1674 [?1213]*, August 1904, Cowcowing (PERTH).

Z. iodocarpum F. Muell. var. *bilobum* Benth., *Fl.Austral.* 1: 293 (1863).

Possible holotype: J. Drummond 91, s.dat.[received 1848], [Western Australia], Swan River to the S[tirlings] (K, seen as photograph in Eichler MS); *isotype:* MEL16550.

Typification

Z. ovatum Ewart & J. White

The MEL sheet has been chosen as the lectotype since it has mounted with it a note in pencil containing much of the information found in the protologue. This note is presumably in Ewart or White's hand but neither of their handwritings has been found for comparison. There are two specimens of *Z. ovatum* in PERTH labelled as *Koch 1674*, one dated Sept. 1905 on the handwritten labels and the other, August 1904. The former is an isolectotype of *Z. ovatum*, but the latter appears more likely to be a duplicate of *Koch 1213,* collected by Koch from Cowcowing in August 1904 and represented in MEL (MEL1517068). The MEL specimen of *Koch 1213* has been labelled as "Z. ovatum n. sp. Ewart & White" (presumably by one of the authors, but not the one who wrote the pencilled note on the lectotype), and has also been labelled as a cotype of *Z. ovatum.* The specimen is certainly not mentioned in the protologue, but since it has been annotated by the authors and also bears the designation cotype, there seems little doubt that it should be considered as a syntype. The second specimen in PERTH, which is erroneously labelled either with respect to the Koch number or date and locality, is an isolectotype if the Koch number is correct or a syntype if the date and locality is correct.

Z. iodocarpum var. *bilobum* Benth.

The K material has been annotated as "Z. iodocarpum var." and possibly represents the only material to have been seen by Bentham. However Drummond collected up to 16 sets of each species for sale and so there could easily be more isotype material to be identified. A duplicate in MEL was not been seen by Bentham.

Zygophyllum crenatum F. Muell., *Linnaea* 25: 374 (1853).

Zygophyllum glaucescens var. *lobulatum* Benth., *Flora Austral.* 1: 293 (1863).

Type citation: Ad rivo Rocky river lacum Torrens versus locos depressos pusillum salsos sparsim inhabitans.

Syntypes: *F. Mueller s.n.*, Oct. 1851, [South Australia] Cudnaka [Kanyaka], in depressis [subsalsis] (MEL95448); *F. Mueller s.n.*, Oct. 1851, [South Australia], Cudnaka, Rocky creek, Crystal Brook, Akaba (MEL110968 - herb. Sonder).

Typification

A Mueller specimen, annotated by him as "Roepera crenata", was collected at Cudnaka in the Flinders Ranges in October 1851. This sheet in MEL (MEL95448) had been labelled as the holotype. Annotations on the specimen bear some relation to the protologue. However this is not the only specimen. There is a second Mueller specimen in the Sonder herbarium in MEL which has further information on its label. This may prove to be a more appropriate choice as lectotype. It has fruits and flowers present.

Zygophyllum humillimum Koch, [*Trans. Roy. Soc. S. Australia* 24(2): 82 (Dec.1900), nom. prov.]; Koch ex Tate, *Trans. Roy. Soc. S. Australia* 24(2): 207 (Dec.1900); Koch ex J.M. Black, *Fl.S.Austral.* 334 (1924).

Lectotype here designated: *M. Koch 457*, 12 June 1899, [South Australia], Mt Lyndhurst (AD97918160 - herb. Tate), ***isolectotype***: AD97918159 – herb. Black. ***Other syntypes:*** *M. Koch 457*, Aug. 1899, [South Australia], Mt Lyndhurst (AD96247051, BM, K, NSW391140).

First publication of the name

The place of publication of *Z. humillimum* has to be reconsidered. Koch included this species in a discussion on the micromorphs of *Z. ammophilum* (Koch 1900), referring to it as "*Z. ammophilum* var. or new species (?);". He further stated that he has supplied Prof. Tate with more material and "would not be surprised if he decides to raise No. 457 to specific rank... I suggest as an appropriate name *Zygophyllum humillimum*."Thus even though he provided a discussion of all of the characteristics which made this particular species distinct, the name was "proposed in anticipation of the future acceptance" of the species and as such contravenes Article 34.1 of the ICBN (Greuter et al. 1992).

This is in agreement with notes to be found in the Eichler manuscript under this species and an unsigned annotation on the isolectotype in K. Both of these sources then attribute the first official publication of the name to J.M.Black in 1924.

However within the index of the volume in which Koch published his notes and proposed the name, reference was made to "Zygophyllum *humillimum*" and beneath the explanation of the index it is stated that "specific names in italic type are described as new". Thus the official place of publication of the species can be cited as the index with reference back to the article in which Koch discussed *Z. humillimum*. As the volume was edited by Tate, the botanist to whom Koch deferred in proposing his new species, and Tate was presumably responsible for the index, the authorship of the name should be cited as Koch ex Tate. Tate would have had two opportunities to comment on this taxon, the first being when the paper was read to the Society on June 5th, 1900 and the second when he edited Koch's article for the journal, but apart from the Index there seems to be no other indication of what Tate thought about this taxon. The lectotype sheet in Tate's herbarium bears no annotation by him and has been annotated only by Koch and by J.M. Black (see below).

It is interesting to note that in a later compiled index to volumes 1–24 of *The Transactions of the Royal Society of South Australia*, the compiler, R.J.M. Clucas (1907), did not consider the reference to be "to the original or to a fairly full description" of the species, since it was not followed by an asterisk.

Typification

Koch's collections numbered 457 are from two gatherings, one made on June 12th 1899 and the other in August 1899. Of the two specimens collected in June 1899, one resides in the Tate Herbarium and the other in the Black Herbarium. The Tate herbarium sheet consists of 2 whole plants and 2 robust branches, while the specimens in the Black

herbarium are probably pieces off the collections on the Tate sheet; they have been mounted with Black's detailed analysis and drawings. Koch has annotated the Tate herbarium collection as "Zygophyllum sp." He further remarks on the label that

> "This Zygophyllum may be a new species (unless it is Z. crenatum, which I doubt for Z. crenatum has according to flora N.S.W. "2 seeds in each cell and this Z has only one seed in each cell) As the fruit resembles that of Z. am[m]ophilum I believe this Z. is a cross between Z. prismatothecum and Z. am[m]ophilum which I found near it."

Alongside this is pencilled "no" but there is no indication of who wrote this. There are further notes written by Koch on the back of the collector's label attached to the sheet. These are obviously addressed to Tate since he says that "I should be inclined to look for it in your Handbook under "I. Capsule truncate at the top", a clear reference to the treatment of Zygophyllaceae by Tate (1890) in his *Handbook of the Flora of Extratropical South Australia.* This is followed by a description of the plants. This sheet has subsequently been labelled as "humillimum M.Koch" by J.M. Black. There are no annotations on it by Tate. Despite the lack of the name in either Koch's or Tate's hand this specimen has been chosen as lectotype since it seems to best reflect the history of the naming of the species.

Of the syntype collections, the one in BM is labelled by Koch as "Zygophyllum ammophilum fv.M. var., unlike the typical form", while the specimen in K is labelled as "Zygophyllum sp., seems to be undescribed - resembling Z. am[m]ophilum". The specimen in NSW is, in contrast, labelled by Koch as "Zygophyllum sp. nov., provisionally named humillimum".

Zygophyllum billardierei DC., *Prodr.* 1: 705 (1824), as 'Billardierii'.

Type citation: in Novae-Hollandiae terrae Van-Leuwin.

?Holotype: *Labillardiere*, s.dat. [], terra van Leuwin [Western Australia] (G-DC); isotypes: ?FI, ?P.

Zygophyllum billardierei (as 'Billardieri') var. *stenophyllum* F. Mueller ex Diels & Pritzel, *Bot. Jahrb.* 35: 314 (1904) p.p. (at this stage only as to Forrest collection, Diels collection not seen, but probably not this species because of locality).

Type citation: in distr. Coolgardie orientali: Musgraves Range (32°14′ lat.,126° 24′ long.) flor. et fruct. m. Nov. leg. *J. Forrest*; pr. Gilmores haud procul a Lake Cowan in eucalyptetis lapidoso-lutosis fruct. m. Nov. (D. 5459).

Syntype: J. Forrest s.n., 1870, [Western Australia], Musgrave's Range, Lat 32°14′ Long 126° 24′[?Wurrengoodyea Hills north of the Eyre Telegraph Stn on the Great Australian Bight] (MEL56866).

Zygophyllum ammophilum auct. non F. Muell.; F. Muell., *Fragm.Phyt.Austral.* 11: 28(1878) p.p. (only as to possible syntype specimen from Port Lincoln (MEL110961, herb. Sonder).

Typification

Z. billardierei var. *stenophyllum* F. Mueller ex Diels & Pritzel

Mueller applied the name var. *stenophylla* to the very succulent, small-leaved collections of *Z. billardierei* DC. from Port Lincoln and Yorke Peninsula. He annotated one J.S. Browne specimen from Port Lincoln as var. *stenophylla* (MEL56871) and another (MEL94973), possibly a duplicate, as "Zygophyllum billardierei var." Diels & Pritzel saw a Forrest collection in MEL from Musgraves Range (near the Eyre Telegraph Station on the Great Australian Bight) which had been annotated by Mueller as "var. (ammophila) stenophylla", and adopted var. *stenophylla* for a Diels collection from Lake Cowan, near Norseman, citing it and the Forrest collection in the protologue. While there is no doubt that the Forrest collection belongs with *Z. billardierei* DC., it is unlikely that the Diels specimen will prove to be the same species, since *Z. billardierei* is confined to coastal localities and the Diels collection comes from much further inland.

Zygophyllum ammophilum F. Muell., *Linnaea* 25: 376 (1853), nomen nudum; *Fragm. Phyt. Austral.* 11: 28 (1878).

Zygophyllum billardierei (as `Billardierii'') var. *ammophilum* F. Muell., Report of Mr. Babbages Expedition into the North West interior of South Australia. *Votes Proc.Legis.Assembly 1859-60*, 7 (1859); nomen nudum.

Z. billardierei DC. var. *ammophilum* (F. Muell.)J.M. Black, *Fl.S.Austral.* 2: 333 (1924) p.p., at least to specimens with 4 stamens.

Type citation: Ad flumina Wimmera, Murray- et Lachlan-River (F. M.), Darling-River (Beckler), ad sinum Port Lincoln (Browne), ad fluvios Warrego (Bailey), Barcoo (Gregory), ad oras Great Bight (Carey), ad fontes Alice-Springs et Charlotte-Waters (Giles), ad Champion-Bay et Murchison-River (F. M.). Huc forsan plants Drummondi 91."

Lectotype: "*F. Mueller s.n.,* Lachlan River, Sept. 1878 (MEL 56877).", fide H. Eichler, *Telopea* 4(1): 16 (1990).

Typification

The epithet "ammophilum" was used as early as 1853 by Mueller in *Linnaea,* but the name was not accompanied by a description. In 1859 Mueller again used the epithet in describing *Zygophyllum billardierei* var. *ammophilum* from the Babbage Expedition and there is possibly some argument that this should be the basionym for this species. However the description consists merely of "narrow leaved variety peculiar to desert" and so is best treated as a nomen nudum as it could represent any one of a number of presently recognised species and the specimen has still to be located..

Valid publication of the name was not until 1878 and by that time Mueller had accumulated a great deal of material as can be seen from the type citation. The syntypes were found by Eichler to represent a number of different species and so he (Eichler 1990) lectotypified *Z. ammophilum*, choosing a specimen with 4 stamens which was in agreement with the protologue.

The rest of the syntypes have still to be allocated to species.

****Z. sessilifolium* L. a short-lived South African introduction to Australia**

There are specimens attributed to a South African species, *Z. sessilifolium* L., in MEL. These were collected from Coode Island in the Port of Melbourne. They were collected in 1908, and exhibited by J.R.Tovey at the Victorian Field Naturalists Club on 8th May 1911 (note on *MEL95370*). It would appear that *Z. sessilifolium* persisted only for a few years or was eradicated. It can be distinguished from the Australian species of *Zygophyllum* by its shrubby perennial habit, white flowers with 5 petals c. 1 cm long and ?erect, ?5-lobed fruits c. 12 mm long, similar in shape to those of *Z. kochii,* to which it would appear to bear some relationship. The leaflets of these Coode Island specimens are shortly petiolate and distinctly acuminate, somewhat at odds with the Linnean type seen on microfiche (*LINN 544.5*).

Specimens examined:

VICTORIA: *J.R. Tovey & C. French Jr. s.n.*, Oct. 1908, Coode Island (MEL95368); *J.R. Tovey s.n.*, Oct. 1908, Coode Island (NSW); *J.R.Tovey s.n.*, 28 June 1911, Coode Island (MEL95369); *J.R. Tovey s.n.*, 1908, Coode Island (MEL95370); *Anon. s.n.*, 9 Nov. 1912, Coode Island (MEL1503736); *Anon. (ex herb.W.R.A. Baker) s.n.*, 9 Nov. 1912, Coode Island (MEL95402, MEL95403).

Species incertis

Zygophyllum fruticulosum var. *platypterum* Benth., *Flora Australiensis* 1: 294 (1863).

Type citation: Port Jackson, Leichhardt (Herb. F. Mueller).

Syntypes: *Leichhardt [Herb. Mueller] s.n.*, s.dat., Port Jackson (MEL s.n.); *Anon. s.n.[Herb. Mueller]*, s.dat., Without locality (MEL s.n.); *Leichhardt [Herb. Mueller] s.n.*, s.dat., Port Jackson (MEL s.n.); *Anon. s.n.*, s.dat., raised from seed in Sydney (MEL s.n.).

Within the Eichler manuscripts there are photographs of the three syntypes mentioned above. There is presumably a specimen to be found at K as well although it is possible that Bentham saw the first listed syntype (there is no "B" to indicate this, but one of the labels appears to have been annotataed by him as "Z. fruticulosum var?"). It seem s clear that the species was cultivated at the Sydney Botanic Gardens since one of the specimens says "probably cultivated" and Mueller has annotated the first listed syntype as "Z. morg[s]anae affine. Forsan ex horto bot Sydneyano." The identity of the plant is unknown but it would appear to be a non-Australian species since the leaves are not divided into leaflets.

Excluded species

Zygophyllum australasicum Miq., *Pl. Preiss.* 1: 164 (1845).

Type citation: "Crescit in clivulis arenosis insulae Cornac, 8. Nov. 1839. Herb. Preiss. No. 2397".

Types: L. Preiss 2379, 8 Nov. 1839, In Nova Holland ora [occid] in clivulis arenosis insula Carnac [off Fremantle, Western Australia] (U); *L. Preiss 2379*, s.dat., New Holland, Riv. des Cygnes [Swan River, Western Australia] (P). Both seen as photographs in the Eichler collection of protologues.

Although it is difficult to make out any detail form the photographs there is little doubt from the description that the type collection is *Nitraria*. Reference to pubescence on the branches, sepals and the ovary would rule out any Australian species of *Zygophyllum* and accords with *Nitraria billardierei* as does the 5-angled ovary which continues into the style.

Acknowledgements

As in the previous paper, this one has relied to some extent on earlier work done by Hansjoerg and Marlies Eichler and Alison Rowell. I hope that the debt owed to them has been at least partly expressed in the choice of epithets for the new species.

Thanks to Paul Wilson for commenting on the first place of publication of *Zygophyllum humillimum.*

Illustrations of the new taxa are by Beth Chandler, employed under ABRS funding to prepare plates for the *Flora of Australia* treatment of Zygophyllaceae, and the AD artist, Gilbert Dashorst. Thanks to both of them and to both ABRS and the State Herbarium for making their services available.

Once again, thanks to all Australian herbaria who have loaned specimens, to ABRS who partially funded this work in its early stages and to the staff of the State Herbarium of South Australia for everything they do to facilitate such work.

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BOOK REVIEW

CSIRO Handbook of Australian Weeds. M. Lazarides, K. Cowley & P. Hohnen (1997) pp 264. (CSIRO Publishing: Collingwood.) Softbound $A49.95.

This book will be an essential reference to plant names for Australian weed scientists. It comprises an alphabetical list of 2,733 species and infraspecific taxa of vascular plants, with brief notes on their life form and uses, and cross-indexed by families and common names. Their distribution in Australia is shown by a thumbnail map on which the States from which the taxon is recorded are shaded, and overseas distribution is briefly noted.

There is a bibliography with 244 entries, and each listed taxon is cross-referenced to at least one, and often many, of these source publications. The book is thus an entry point to the literature for each listed plant.

Less useful are the "343 references from misapplied or invalid names to valid ones". Misapplied names, a major stumbling block to the study of introduced flora, are here clearly indicated as such. But the authors' concept of invalid names includes synonyms of various kinds, and the limited space has not allowed any discussion of names treated in synonymy. For instance, no reason is given for choosing *Cuscuta campestris* Yuncker, over the validly published taxonomic synonym *Cuscuta pentagona* Engelm., as preferred name for golden dodder.

This publication derives from Lazarides and Hince's CSIRO Handbook of Economic Plants of Australia. Where relevant, criticisms of that volume have been addressed in the preparation of this new publication. But it necessitated searching a large volume of literature, and an impression lingers that this was sometimes done uncritically. For example, all Flora of Australia treatments are still attributed to "George, A.S. (ed)" instead of to their respective authors.

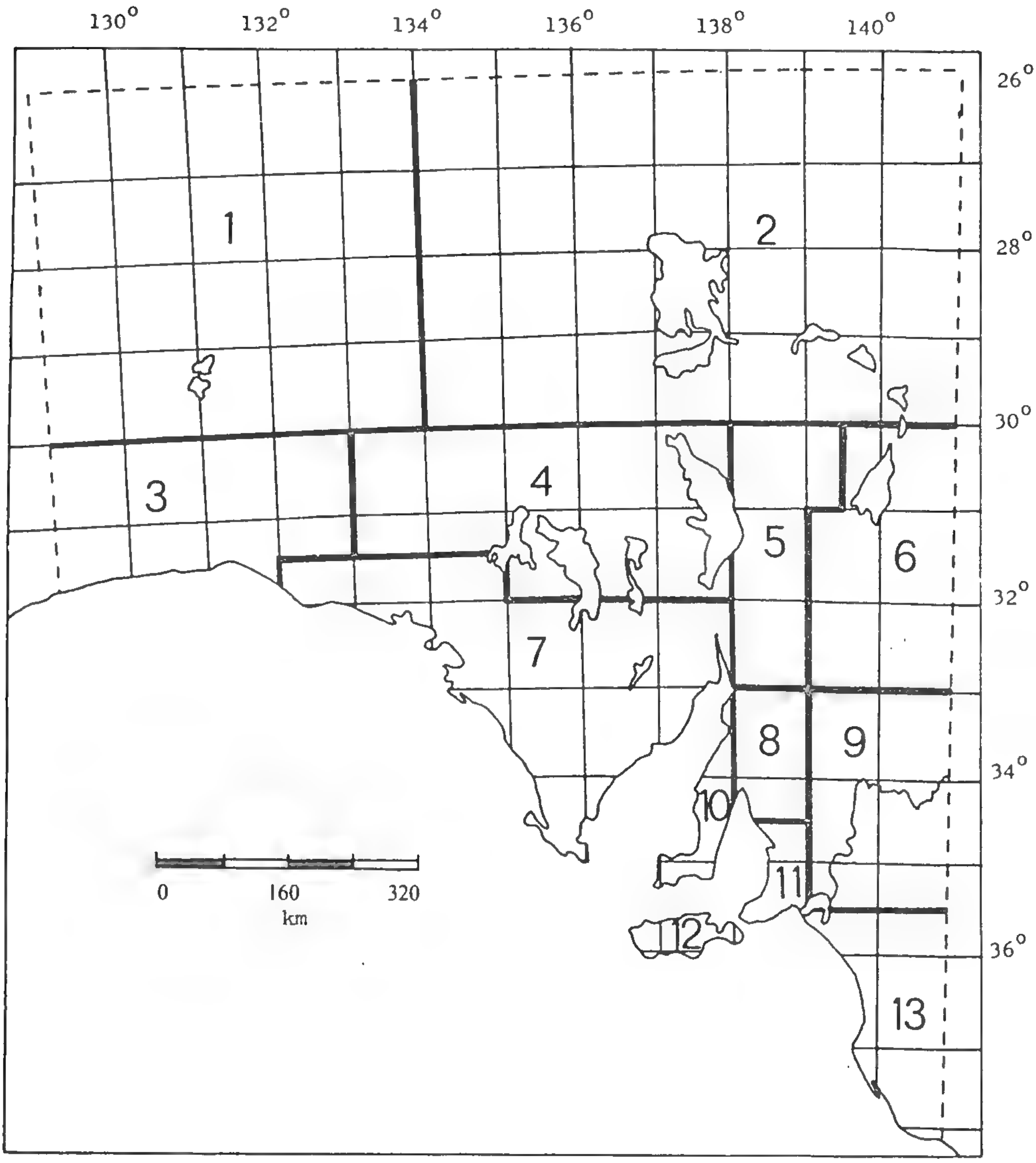
The Introduction acknowledges the difficulty of defining the term 'weed'. This simple English word denotes a value judgement, not an existential category of plants. The authors have advisedly given the term its broadest possible meaning, including both rare garden escapes (e.g. *Moraea aristata*) and native plants that persist on cleared land (*Haloragis* and *Lomandra*) or have extended their range due to human influence (*Pterostylis dilatata*). One consequence is that native *Cycas* species, even the vulnerable local endemic *C. kennedyana*, are listed as weeds because the whole genus is proclaimed noxious in Queensland.

The choice of species included on such a list will almost inevitably be controversial. Anyone with an interest in native or introduced plant will find it worth their while to browse this publication, if only for the chance of gaining a new viewpoint on some familiar species.

D.A. Cooke
Animal and Plant Control Commission of South Australia

REGIONS OF SOUTH AUSTRALIA ADOPTED BY THE STATE HERBARIUM — ADELAIDE

1. North-western
2. Lake Eyre
3. Nullarbor
4. Gairdner-Torrens
5. Flinders Ranges
6. Eastern
7. Eyre Peninsula
8. Northern Lofty
9. Murray
10. York Peninsula
11. Southern Lofty
12. Kangaroo Island
13. South-eastern



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Papers will be accepted in the following categories:
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Manuscripts must be typed, with double spacing and margins at least 3 cm wide, on one side of the paper only. Three copies must be submitted. Captions must not be italicized, underlined or typed in capitals. All scientific names of genetic or lower rank must be underlined.

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Text references to publications should be indicated as follows: (Smith, 1959), (Smith, 1959, p. 127), Smith (1959) or Smith (1959, pp. 125-208). The final section of the paper, headed 'References', should include only those titles referred to in this way. It should be laid out as follows:
Smith, L. L. (1879). The species of *Danthonia* found in pastures in Victoria. *Austral. J. Bot.* 65: 28-53.
Bentham, G. (1868). "Flora Australiensis", Vol. 4.(L. Reeve: London).
Baker, J.G. (1898). Liliaceae. In Thiselton-Dyer, W. T. (ed.). "Flora of Tropical Africa", Vol. 7. (L. Reeve: Ashford).
Journal abbreviations must be consistent within a paper and authors are recommended to follow "Botanico-Periodicum-Huntianum". Journals not cited in B-P-H should be abbreviated to conform with this general pattern. The following abbreviations for Australian states should be used: WA, NT, SA, Qld, NSW, ACT, Vic., Tas.
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Benth., *Fl. Austral.* 4: 111 (1868) OR
Benth., *Fl. Austral.* 4: (1868) 111.

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Authors wishing to cite all specimens seen may list them all in an index to collectors after the style of the "Flora Malesiana" identification lists. Collections not identifiable by a collection number (assigned by either the collector or herbarium) should cite dates.

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NOTES ON THE GENUS *TRIBULOPIS* (ZYGOPHYLLACEAE) IN AUSTRALIA

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Abstract

A background is given to the genus *Tribulopis* R. Br. (Zygophyllaceae), an Australian endemic. The genus is lectotypified as are a number of species. Two new combinations, ***Tribulopis homalococca*** (Domin)R.M. Barker and *Tribulopis homalococca* var. ***alifer*** (Domin)R.M. Barker are made and three possibly new taxa are described but not given formal status because of the limited material available. A key, notes on distribution and habitat, comments on variability and dispersal of the taxa and their distinguishing features, all or selected specimens and illustrations are provided for all of the taxa.

Background

Tribulopis was first described as a genus distinct from *Tribulus* L. by Robert Brown (1849) in the Appendix to Sturt's Expedition into Central Australia. According to Brown, he had recognised the genus 40 years before, and there is no reason to doubt this since the three species he described (*T. pentandra* R. Br., *T. angustifolia* R. Br. and *T. solandri* R. Br.) were all based on his own collections from northern Australia. Mueller (1858), in describing a fourth species in the genus, *T. bicolor,* erroneously referred it to '*Tribulopsis*', thus causing confusion as to the correct spelling. He later (Mueller, Feb. 1862) reduced *Tribulopis* (still as '*Tribulopsis*') to a subgenus of *Tribulus* as did Bentham & Hooker (Aug. 1862), although it has been the latter who have been attributed with this reduction in the past.

This latter placement of the species within *Tribulus* was followed by the majority of workers until the 1960's. One exception was Engler & Prantl (1890), who transferred a number of Australian *Tribulus* and *Tribulopis* species to *Kallstroemia* Scop. As a result there have been sporadic listings of this genus for Australia (e.g. Burbidge 1963, Beard 1965). It was not until Porter (1969) considered the generic relationships of *Kallstroemia,* and restricted it to the Americas, that *Tribulopis* was again considered at generic level. Porter advocated its resurrection, indicating that *Tribulopis* could be distinguished from *Tribulus* by its single ovules per locule (versus 2–5 in *Tribulus*).

Porter considered the genera *Tribulus, Tribulopis, Kallstroemia* (c. 17 American species) and *Kelleronia* (c. 10 North African species) to form a natural assemblage within Zygophyllaceae, sharing the characteristics of prostrate herbs with opposite, even-pinnate leaves, pentamerous flowers with 10 stamens in 2 unequal rows and without any appendages on the filaments, indehiscent fruits and polyforate pollen. On this basis he (Porter 1972) proposed the subfamily Tribuloideae to include these genera, but excluded the genera *Neoluederitzia* and *Sisyndite* which had previously been treated as part of this group. Recent phylogenetic work on Zygophyllaceae by Sheahan & Chase (1996), based on morphological, anatomical and rbcL DNA sequences, has reinstated the genera excluded by Porter into the subfamily Tribuloideae, with the possible addition of *Balanites* as well.

Keighery (1982) published an account of geocarpy in the fruits of *Tribulopis* and also considered the generic status of *Tribulopis,* recommending its readoption and listing a suite of characters associated with the geocarpic dispersal syndrome. New combinations in *Tribulopis*, without any discussion of generic status, were made by Eichler (1984) in preparation for the Western Australian plant census (Green 1985).

While the species involved are now usually referred to *Tribulopis*, there has been no treatment of the whole genus Australia wide, since that of Bentham. Lawrence's (1992) treatment considered all of the presently named species but was restricted to the Kimberley region.

Tribulopis, Tribulus and *Kallstroemia*

Characters used to separate *Tribulus* and *Tribulopis* in the past include

- alternate leaves in *Tribulopis* vs opposite leaves in *Tribulus*
- fruits pyramidal in *Tribulopis* vs non-pyramidal in *Tribulus*
- style and stigma persistent in *Tribulopis* vs style and stigma deciduous in *Tribulus*
- ovules 1 per cell in *Tribulopis* vs ovules 2–5 in *Tribulus*

While these characters work most of the time, there are exceptions, and it is possible that there are no uniquely derived characters to separate the two genera. The opposite leaves of *Tribulus* are usually markedly unequal in size and in many of the Australian species, the smaller of the pair may be completely suppressed, giving an apparent alternate leaf arrangement, as in *Tribulopis*. The pyramidal fruit so characteristic of *Tribulopis* is also apparent in *Tribulus astrocarpus* F. Muell. Indeed it is comparatively easy to envisage the fruits of this species as a precursor to those of *Tribulopis* or vice versa. The style and stigma persist on the apex of the fruit of *T. astrocarpus* just as they do in *Tribulopis* species, and investigation of all Australian *Tribulus* species reveals the presence of the style and stigma in the mature fruit before breakage into fruitlets.

The greater number of ovules per cell in *Tribulus* when compared to *Tribulopis* would appear to have only one exception. Investigation of *Tribulus platypterus* Benth. reveals that it shares with *Tribulopis* the single ovule per cell. However its sister species, *T. suberosus* H. Eichler ex R.M. Barker, has two ovules per cell. Both *T. platypterus* and *T. suberosus* are unique in this grouping by their shrubby habits (see Barker 1998).

One character which has been used to some effect here is the size of the leaflet pairs becoming larger towards the apex of the leaf in *Tribulopis* but smaller in *Tribulus*.

Species of both *Tribulus* and *Tribulopis* were assigned to *Kallstroemia* in the past but there is little doubt that the Australian species are distinct from the American *Kallstroemia*. That genus is characterised by its 10-lobed ovary and stigma rather than the 5-lobed state found in *Tribulopis* and *Tribulus*. *Tribulopis* shares with *Kallstroemia* the 1-ovulate state and a very similar fruit morphology (see Porter 1969, Fig. 1–16).

Present status of species assigned to *Tribulopis*

T. pentandra R. Br., *T. angustifolia* R. Br., *T. sessilis* (Domin) H. Eichler, *T. bicolor* F. Muell., *T. solandri* R. Br. and *T. homalococca* (Domin)R.M. Barker are all recognised at species level below, together with four other potentially new taxa.

T. pentandra R. Br. is widespread across northern Australia and usually easily recognisable by its 5 stamens and leaves with 2 pairs of leaflets. Two potentially new taxa, related to *T. pentandra,* have been recognised from the Kimberley region of Western Australia, one from the Koolan Island area and the other from the Mitchell Plateau.

T. angustifolia R. Br. displays a great deal of variation. Lawrence (1992) reduced the previously recognised *T. curvicarpa* (W. Fitzg.) Keighery and *T. affinis* (W. Fitzg.) H. Eichler to synonyms of *T. angustifolia*, a decision which has been followed here, along with reduction of *Tribulus leptophyllus* Bailey to a synonym of this species. However it would not be surprising if some infraspecific taxa were to be recognised in the future. Extensive field work and herbarium study will be required if there is to be an understanding of the

variation involved. A potentially new taxon, restricted to the Mt Isa area, is most closely related to *T. angustifolia.*

Tribulopis solandri R. Br. was recorded from the Kimberley's by Lawrence but this species has been restricted to Cape York Peninsula in this treatment. Those species in Western Australia previously referred to *T. solandri* are now referred to *T. bicolor* F. Muell. It is possible that *T. solandri* and *T. bicolor* may not prove to be specifically distinct with further study across the range. Characters to separate the two are difficult to find, but the species level has been maintained for the present. A potentially new taxon confined to Lizard Island is most closely related to *T. solandri.*

The four potentially new taxa all appear to be quite distinct, but the small number of collections involved and the lack of notes associated with the collections, make it premature to recognise them formally. Any extra collections of any of these taxa would be greatly appreciated by the author. Flowering and fruiting is associated with the end of the wet season and good collections of most species are normally made from February to May.

Additional notes on floral characteristics and fruit dispersal would also be useful. Confirmation of Keighery's notes on the geocarpy of certain species is also needed. It seems much more likely in those species in which the pyramidal fruits split into fruitlets at maturity that hydrochory, or even zoochory, might be involved in dispersal of these plants. The brittleness of the mature fruits and their readiness to break into fruitlets suggests similarities to *Tribulus* and its "trample' mechanism of dispersal, but the outgrowths in the form of paired bumps or rounded "spines" are not really designed for adherence to the trampler.

The author would be pleased to hear of any comments on the following treatment in order that the manuscript can be upgraded before its inclusion in the *Flora of Australia.*

TAXONOMIC TREATMENT

Descriptions have not been included for those species which have already been published, only those taxa which are potentially new. All of the specimens seen have been cited for a particular taxon unless otherwise indicated.

TRIBULOPIS R. Br. in Sturt, *Expedition into Central Australia* 2 *App.* 70 (1849); H. Eichler, *Fl. Central Austral.* 184 (1981); Keighery, *Flora* 172: 333 (1982); H. Eichler, *Nuytsia* 5: 177 (1984); Lawrence, *Fl. Kimberley Region* 675 (1992).
Lectotype here designated: *T. angustifolia* R. Br.

Tribulopsis F. Muell., *Fragm.* 1 (1858) 47, orthographic variant.

Tribulus subg. *Tribulopis* (R. Br.)F. Muell. (as '*Tribulopsis*'), *Pl. Indig. Colony Vict.* 1: 99 (Feb. 1862); Hook. in Benth. & J.D. Hook., *Gen. Pl.* 1: 264 (Aug. 1862).

Tribulus auctt. non L.: Benth., *Fl. Austral.* 1: 287 (1863) p.p. (only with respect to *T. pentandrus, T. bicolor, T. solandri* and *T. angustifolius*); F.M. Bailey, *Queensl. Fl.* 1: 171 (1899); Ewart & Davies, *Fl. N. Terr.* 154–156 (1917); Domin, *Biblioth. Bot.* 89: 280 (1926) p.p.

Kallstroemia auct. non Scop.: Engl. in Engl. & Prantl, *Die Nat. Pflanzenfam.* 3(4): 88 (1890) p.p. (only with respect to *K. angustifolia, K. bicolor, K. pentandra* and *K. solandri*)

Prostrate, usually pubescent annual or short-lived perennial herbs. *Leaves* alternate, not succulent, stipulate, the stipules markedly unequal, 2–6-foliolate; leaflets not continuous with petiole, not stipellate; petiole terete. *Flowers* solitary. *Pedicel* usually erect in flower, deflexed in fruit. *Sepals* 5, not persistent in fruit. *Petals* 5, free, quickly deciduous, yellow, not fading to white, longer than sepals. *Stamens* 10 or fewer, usually in 2 subequal whorls; filaments not winged. Extrastaminal nectariferous disc lobes 5; intrastaminal disc 5 free

lobes or sinuate ring or lacking. *Ovary* 5-celled; ovules 1 per cell; style short; stigma 5-ridged, papillose. *Fruit* a pyramidal schizocarp topped by persistent style and stigma, pendent, dissociating into 1–5, indehiscent, smooth or reticulate mericarps, often with pair of basal or median conical spines or protuberances, rarely with a semicircular wing.

C. 10 species, endemic to northern Australia. Flowering towards the end of the wet season.

Typification

In recognising the genus *Tribulopis,* Brown (1849) commented on the distinction of the American species of *Tribulus* L. from the rest of the species of *Tribulus* proper by their "10 monospermous cocci, by their persistent calyx, and the absence of glands subtending the 5 filaments opposite to the sepals." This group of species had been recognised as a separate genus, *Kallstroemia,* by Scopoli. Brown commented that there was a further genus which he had recognised 40 years previously in the Banksian Herbarium, which he called *Tribulopis* which could be distinguished by its deciduous calyx, 10 stamens (reducing to 5), glands subtending the 5 filaments opposite the sepals and the 5 monospermous cocci often with 2 or 4 tubercles at their base. All were prostrate annual herbs with all leaves alternate. He described 3 species, *T. solandri*, *T. angustifolia* and *T. pentandra*, all of which are available for lectotypification of the genus.

All three species fit the description given above. However *T. pentandra* has 5 rather than the normal 10 stamens for the genus and so is somewhat atypical. Either of the other two species would serve equally well as type species of the genus but *T. angustifolia* has been chosen rather than *T. solandri* because it is much more common and widespread.

Provisional key to *Tribulopis*

1 Leaflet pairs 2 throughout the plant; stamens 5–7

2 Mericarps straight dorsally and with a pair of diverging basal spines [petals 4.5–11 mm long; style 1–4 mm long, thickened; widespread .... **1. *T. pentandra***

2: Mericarps curved dorsally, lacking basal spines but median and basal protuberances sometimes present

3 Mericarps 1–3 per fruit, reticulate on dorsal surface; style thickened .... **3. *T.* aff. *pentandra* (Koolan Island)**

3: Mericarps 1 per fruit, smooth on dorsal surface, style slender .... **2. *T.* aff. *pentandra* (Mitchell Plateau)**

1: Leaflet pairs more than 2; stamens 10 (including staminodes)

4 Leaflets linear to narrowly ovate; leaflet pairs usually more than 3

5 Lowest pair of leaflets inserted very close to stem; ovary and fruits glabrous; [leaflet pairs 4–5; Kimberleys to Victoria River and Julia Creek area of Qld, on alluvial silts or black or grey cracking clay] .... **5. *T. sessilis***

5: Lowest pair of leaflets inserted well above stem; ovary and fruits pubescent

6 Ovary covered with white appressed hairs; petals 5–7.5 mm long; mericarps 5–6 mm high, appressed pubescent, with median and basal spines [leaflet pairs 4–5; Mt Isa area] .... **7. *T.* aff. *angustifolia* (Mt Isa)**

6: Ovary covered with dense white erect hairs; petals 3.5–16 mm long; mericarps 5–11 mm high, unarmed, with basal spines only or with median and basal spines, smooth or reticulate dorsally; [leaflet pairs (2-)3–5(-6); across northern Australia, north of the Tropic of Capricorn] .... **6. *T. angustifolia***

4: Leaflets elliptic, ovate or obovate; leaflet pairs usually 3;

7 Flowers yellow throughout or with orange or darker centre; lower leaflet pair often inserted close to stem; stamens 5 fertile (globular anthers), 5 staminodal (linear anthers); ovary seated on obvious

sinuate disc [southern Kimberleys in WA through to Victoria River in NT, with extra populations in Katherine and the McArthur River] .... **4. *T. bicolor***

7: Flowers yellow throughout; lowest leaflet pair inserted well above stem; stamens 10 fertile or 1–6 staminodal; ovary with 5 intrastaminal disc glands or with very narrow ring at base

8 Fruits markedly rounded dorsally, sometimes with semicircular wing at base, lacking spines; [slender delicate herbs; young parts with curled white appressed hairs; Cape York Peninsula] .... **10. *T. homalococca***

8: Fruits +/- straight dorsally, with median and basal spines or protuberances

9 Ovary glabrous; fruits glabrous, with median and basal "bumps", not spines; young parts glabrous [Lizard and Flinders Islands off Cape York Peninsula] .... **9. *T.* aff. *solandri* (Lizard Island)**

9: Ovary with 5 bundles of lax white hairs; fruits glabrous or pubescent, with median and basal spines; young parts with curled white hairs [Cape York Peninsula in sand or basalt] .... **8. *T. solandri***

1. Tribulopis pentandra R. Br. in Sturt, *Expedition into Central Australia* 2 *App.* 70 (1849); Keighery, *Flora* 172: 331 (1982); Lawrence, *Fl. Kimberley Region* 676 (1992); – *Tribulus pentandrus* (R. Br.) Benth., *Fl. Austral.* 1: 290 (1863); Ewart & Davies, *Fl. N. Terr.* 156 (1917); W. Fitzg., *J. Proc. Royal Soc. W. Austral.* 3: 157 (1918); Domin, *Biblioth. Bot.* 89: 280 (1926); *nom. illeg.*, predated by *Tribulus pentandrus* Forssk. (1775); – *Kallstroemia pentandra* (R. Br.) Engl. in Engl. & Prantl, *Nat. Pflanzenfam.* 3(4): 88 (1890); – *Tribulus brownii* F. Muell., *Pl. Indig. Colony Vict.* 1: 99 (1862); F. Muell., *Systematic Census Austral. Pl.* 13 (1882); F. Muell., *Sec. Systematic Census Austral. Pl.* 23 (1889); replacement name for *Tribulus pentandrus* (R. Br.) Benth.

Type citation: In insulis juxta fundum sinus Carpentariae Anno 1803, *R. Brown.*

Type collections: Carpentaria, Island s [Morgans Island], 21 Jan. 1803, *R. Brown 21 [J.J. Bennett no. 5219];* BM, BRI 118539, K, (all seen as photographs in Eichler collection of protologues), MEL s.n., MEL(ex E), NSW391137.

Tribulopis bijuga R. Br. MS on specimens and in Brown's unpublished manuscript.

Occurs in Western Australia, Northern Territory and Queensland in a variety of situations ranging from quartzite, sands and sandstones to cracking clay and limestone pavement. Flowers and fruits Jan. - May, rarely Nov. Fig. 1, A–C.

Notes

Where it occurs in rock crevices the fruits may curve down and burrow into the soil (geocarpic), but this characteristic seems not to be as strongly developed in other situations since mature fruits with dissociated mericarps are to be found on a number of specimens.

Specimens in which the fruits are topped with a very short and broad style are frequently bud autogamous (e.g. *J.Egan 3198, Harris 524*)

A single specimen collected from the Bungle Bungles in November (*Menkhorst 777*) was the only collection from outside the months of January to May. It was more robust than usual and already had flowers and fruits present on it, but apparently did not differ in any other respect from *T. pentandra.*

Stamen number is usually 5, but there are variations on this. A number of specimens had 5 fertile stamens and 2–3 smaller staminodes. One specimen agreed in every other characteristic with *T. pentandra* but had 10 fully fertile anthers (*Alvin 77*). Other specimens had 4 fertile stamens with one other filament either with a tiny undeveloped anther or a long linear anther.

Distinguishing features

The *Tribulopis pentandra* group is distinguished from the rest of the species of *Tribulopis* by the stamen number of 5–7 and the 2 pairs of leaflets. The Koolan Island and Mitchell Plateau taxa recognised below are part of the complex, but both differ from true *T. pentandra* in fruit characters. This difference may be related to the breeding system but further collections and field observations are required for a better understanding of the variation involved.

Selected specimens examined

WESTERN AUSTRALIA: behind tailings dam at Argyle Diamond Mines, *L. Alvin 77* (PERTH); Red Rock Creek, Bungle Bungle N.P., *K.A. Menkhorst 777* (DNA); Dead Horse Spring, near Argyle Village, just off the road from Duncan Hwy to Ord River Dam, *Hj. Eichler 22224* (CANB, CHR, DNA, L, MO, NSW, P, PERTH).

QUEENSLAND: 2 km along Royal Arch road from Gulf Development Rd (W of Chillagoe), *K.L. Wilson 8094, J. Clarkson & S. Jacobs* (CANB, MBA, NSW); Pannikan Springs area, 29 km W of Mungana, *A.R. Bean 5601 & P. Forster* (BRI, CANB, MEL); Ridge W of Hilton, 20 km N of Mt Isa, *A. Schmid 623* (BRI); Tick Hill, 44 km E of Dajarra, *Harris 524* (BRI)

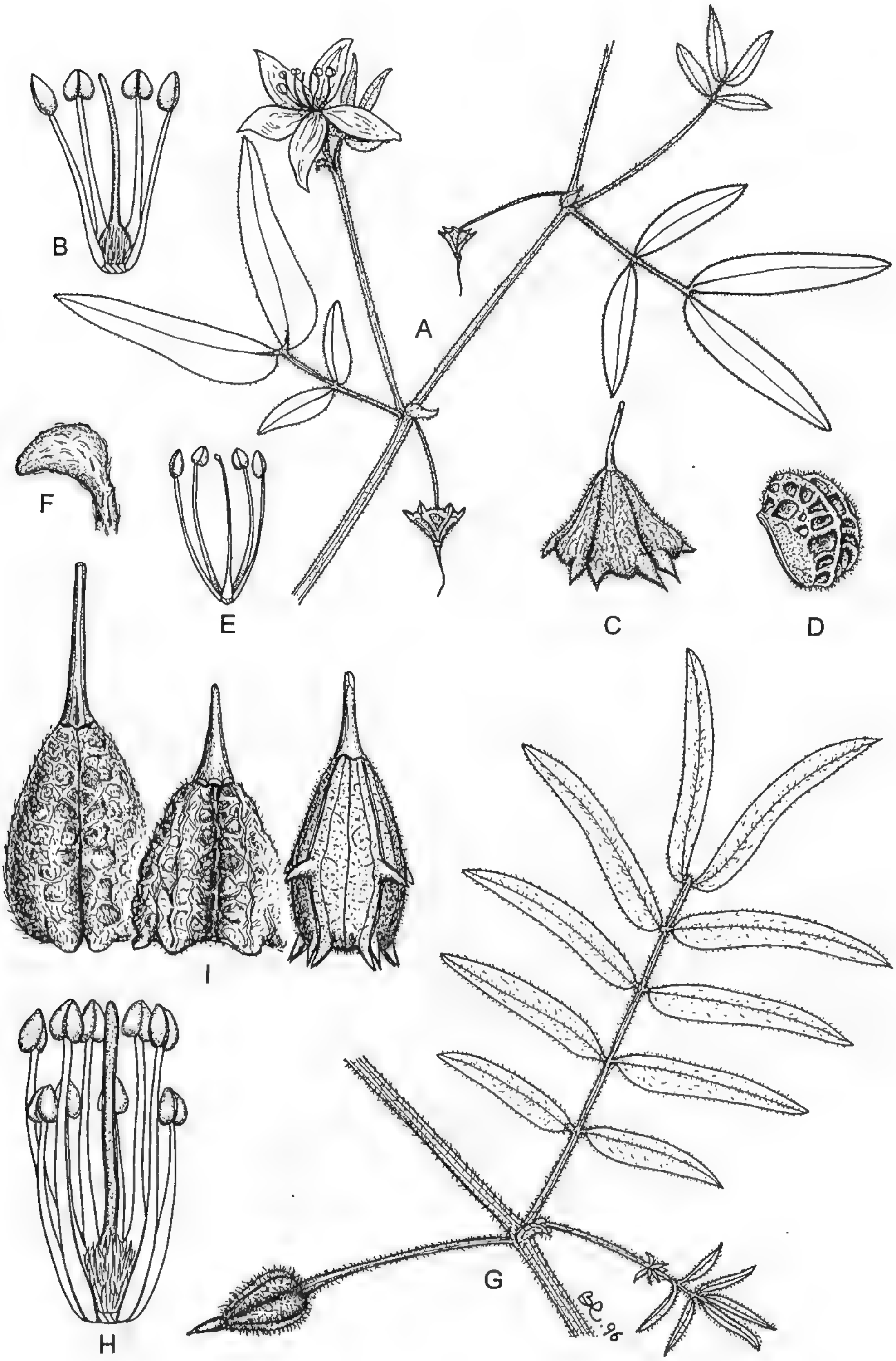
NORTHERN TERRITORY: Keep River N.P., *C.R. Dunlop 5723* (DNA, MEL, NSW); Stuart Hwy, 26 miles N Newcastle Waters turnoff, *J. Must 395* (DNA, PERTH); Mataranka, *J. Egan 3198 & I. Cowie* (DNA).

2. Tribulopis aff. pentandra (Mitchell Plateau)

Prostrate, annual *herb*, sometimes forming mats; stems to 30 cm long, usually hirsute with spreading white hairs. *Leaves* with 2 pairs of leaflets, the lowest pair inserted well above stem; leaflets narrowly elliptic, shortly petiolulate, oblique, acute/acuminate, subglabrous adaxially(upper), white appressed hairs abaxially (lower), upper pair +/- erect, 8–12(-21) mm long, 2–3(-6) mm wide, lower pair smaller, spreading. Flowering pedicel c. 5 mm long, upright, fruiting pedicel 3.5–25 mm long, deflexed, thickened. *Sepals* c. 3 mm long, glabrous adaxially(inner), white-appressed hairs abaxially (outer); margin hyaline. *Petals* yellow throughout, narrowly obovate, 3.5–6.5 mm long, longer than sepals. Extra-staminal glands 5, intrastaminal glands absent. *Stamens* 5, at maturity equal to stigma; filaments c. 2 mm long (c. 1 mm long in smaller flowers); anthers c. 0.5 mm long (0.2 mm long in smaller flowers). *Ovary* appressed white pubescent or glabrous, 5-lobed; style (including stigma) 2 mm long, very slender. *Fruit* with dense short erect pubescence, of 1 tardily dissociating, fully developed mericarp, 1.8–2.5 mm high, dorsally curved, smooth, unarmed or possibly with pair of basal protuberances. Fig. 1, E–F.

Known only from the Mitchell Plateau in the Kimberleys of Western Australia. Larger-flowered specimens are recorded from shallow soils over sheets of exposed basalt and smaller-flowered specimens from *Eucalyptus latifolia* woodland. Keighery, who also noted this difference (Keighery 1982), observed that the smaller-flowered specimens were self pollinating. Flowers Jan.–Feb.

Fig. 1. A–C, ***Tribulopis pentandra*** **A,** Habit (×2); **B,** Flower (×8) with petals and one stamen removed, both *Must 395*; **C,** fruit with style attached (×5), *Leutert 86*; **D,** ***T. pentandra (Koolan Island)***, fruit segment (×5); **E–F,** ***T. pentandra (Mitchell Plateau)*** **E,** flower with petals and one stamen removed (×8) *Kenneally 7935;* **F,** stigma (×8), *Keighery 2630;* **G–I,** ***T. angustifolia*** **G,** habit (×2) *Thomson 1853;* **H,** flower (×8) with petals and one stamen removed; *Leutert 41*; **I,** fruit variation, all fruits topped by persistent style (×5) a, *Cowie 2452*, b, *Dunlop 9689*, c, *Devitt 145*.


A
B
C
D
E
F
G
H
I

Notes

Possibly not distinct from *T. pentandra*, but the lack of any mature fruits means that this cannot be confirmed. Mature fruits are possibly lacking because they have already been covered by soil and break off on collection of the plant. There are a number of tiny immature pyramidal fruits present on the end of thickened pedicels which are glabrous at their apex, but only a single curved mericarp (on *Keighery 2630*) has developed in any of the fruits which have developed further. Unlike other species, the styles on the apex of the fruits are quite filiform and apparently play no part in the mature fruit. This particular taxon may well have its fruits pushed into the soil, aided by the thickened pedicel.

A single specimen (*Mitchell & Handasyde 2099*) allocated to *T. bicolor* because of its leaflet shape and stamen number has fruits similar to those of this taxon; they are likewise topped by a slender filiform style.

Distinguishing features

Part of the *T. pentandra* complex but distinct from that species by the filiform deciduous style and the development of only a single fruitlet with a curved and unornamented dorsal wall.

Specimens examined

WESTERN AUSTRALIA: Mitchell Plateau: C. 26 km N of mining Camp, *K.F. Kenneally 7935* (CANB, PERTH); 1.5 km SE of mining campsite, *K.F. Kenneally 7858* (PERTH); 5 km NE Amax Camp, *G.J. Keighery 2630* (PERTH).

3. Tribulopis aff. pentandra (Koolan Island)

Prostrate, annual *herb*, stems to 50 cm long, usually with appressed hairs often below spreading white hairs. *Leaves* with 2 pairs of leaflets, the lower pair inserted well above stem; leaflets narrowly elliptic, shortly petiolulate, oblique, narrowly acute, subglabrous adaxially(upper), white appressed hairs abaxially (lower), upper pair +/- erect, to 16 mm long, 4.5 mm wide, lower pair smaller, spreading. Flowering *pedicel* 2.5–4 mm long, upright, fruiting pedicel 3–6.5 mm long, deflexed. *Sepals* c. 3 mm long, glabrous adaxially(inner), white-appressed hairs abaxially (outer); margin hyaline. *Petals* yellow throughout, obovate, winged at base, 3–4 mm long, longer than sepals. Extra-staminal glands 5, intrastaminal glands absent. *Stamens* 6–7, all fertile, 5 longer episepalous and 1–2 shorter epipetalous, at maturity equal to stigma; filaments c. 1.5–1.8 mm long; anthers 0.2–0.3 mm long. *Ovary* appressed white pubescent, 5-lobed, impressed and glabrous at base at point of insertion of stamens; style (including stigma) 1.5–2 mm long. *Fruit* shortly pubescent, of 1–3, tardily dissociating, fully developed mericarps, each 3.5 mm high, dorsally rounded and reticulately-patterned, unarmed or with paired median and basal outgrowths. Fig. 1, D.

Known only from Koolan and Sunday Islands in the Buccaneer Archipelago of the Kimberleys of W.A., with a possible further collection from One Arm Point on the adjacent mainland. Occurs in sandstone with the One Arm Point collection coming from "red pindan country over rocky sandstone" and the Sunday Island collection form "skeletal sand amongst sandstone gorges" . Flowers are present on all 3 collections which were made in March and June.

Distinguishing features

The relationships of this taxon are obviously with *T. pentandra* but the rounded dorsal wall of the fruit with its reticulate markings are so different (compare Fig. 1, C & D) that it has been highlighted here to promote further collecting.

Specimens examined

WESTERN AUSTRALIA: Koolan Island, western end, on road to waterfall, SW of Jap Bay, *P.A.Fryxell, L.A.Craven & J.McD.Stewart 4612* (CANB); Sunday Island, Buccaneer Archipelago, *K.F.Kenneally 8278* (PERTH).

Specimen probably belonging to this taxon: 6 km NW of One Arm Point, W of Whimbrel Point, Dampier Peninsula, *B.J.Carter 617* (BRI, DNA, CANB, PERTH).

4. Tribulopis bicolor F. Muell. (as "Tribulopsis") *Fragm.* 1: 47 (1858); Keighery, *Flora* 172: 331 (1982); Lawrence, *Fl. Kimberley Region* 675 (1992); – *Tribulus bicolor* (F. Muell.) F. Muell., *Pl. Indig. Colony Vict.* 1: 99 (1862); Ewart & Davies, *Fl. N. Terr.* 155 (1917); – *Kallstroemia bicolor* (F. Muell.) Engl. in Engl. & Prantl, *Nat. Pflanzenfam.* 3(4): 8(1890).

Type citation: Ad flumen Victoriae in campis subarenosis, *F.Mueller s.n.*

Lectotype here designated: Sandy Island, salt water beach, Victoria River, Oct. 1855, *F.Mueller s.n.* (MEL s.n.); isolectotypes: K(herb. Hooker - 2 sheets, seen as photographs in Eichler collection of protologues), MEL110979 (herb.Sonder), NSW145424.

Distribution & ecology

Occurs in stony skeletal soils ranging from basalts to shale, often in tussock grasslands or on roadsides. Found from southern Kimberleys through to Victoria River, with single outlier populations in Keep River, Katherine and the McArthur River areas. Flowers and fruits March to June. Fig. 2, I–K.

Typification

Mueller originally intended to use "T. anisanthera" as the name for this species; it appears on the MEL sheet as well as the two K sheets.

Notes

Stamen number is usually 10 total, but up to 6 of these (rarely 10 - see next note) stamens can possess longer linear anthers which appear to be non functional or staminodal. These non functional anthers are more likely to be found on the shorter episepalous whorl.

Collections made in August and September from Victoria River Downs (*Robinson R881* from DNA) and Humbert River (*P.Brocklehurst 370* and *M.O.Parker 1030*, both from DNA) possess flowers and fruits but the distance between leaflets is much reduced and the plants are apparently more compact and fleshy; apart from this, they agree with *T. bicolor*, except that they may be short-lived perennials.

Distinguishing features

Often a distinctive species in the field since it is the only one to have a darker coloured centre to the flower, but this information is not usually available for dried specimens. Nor do all flowers have a darker centre and in the absence of this character it is often difficult to distinguish *T. bicolor* from the other species with 3 leaflet pairs, particularly *T. solandri* (the two are possibly not deserving of separate species status). Differences include the smaller obovate leaflets of *T. bicolor* (6–9.5 mm long) compared with the elliptic to obovate leaflets up to 18 mm in *T. solandri,* and all 10 stamens being fertile in *T. solandri* whereas up to 6 may be staminodal (long linear anthers) in *T. bicolor*.

Selected specimens examined

NORTHERN TERRITORY: 27.6 km NE of Cape Crawford roadhouse on Borroloola road, *K.L. Wilson 5316* (CANB, NSW); 26 km E Victoria River Crossing, *C.R. Dunlop 6904* (CANB, DNA, MEL, MO, PERTH); Keep River area, *R. Roos s.n.* (DNA7361).

WESTERN AUSTRALIA: Kelly Bore, c. 25 km E of Ord River H.S., *Hj. Eichler 22387* (AD, CANB, CHR, LAE, L, NSW, PERTH); Gogo Stn, on the road to Quonbon, *A.A. Mitchell & T. Handasyde 2099* (BROOME, CANB, PERTH).

5. Tribulopis sessilis (Domin)H. Eichler, *Nuytsia* 5: 177(1984); Lawrence, *Fl. Kimberley Region* 677 (1992); Basionym: *Tribulus solandri* var. *sessilis* Domin, *Biblioth. Bot.* 89: 281 (1926).

Type collections: Nordwest-Queensland: Grassflachen der Rolling Downs zwischen Richmond und Cloncurry, Feb. 1910, *K.Domin 5504* (PR p.p.); Nord- Australien: Victoria River, Dec. 1865, *F.Mueller s.n.* (PR p.p., K).

An apparently rare species known only from the Kimberley region, from Liveringa, Brooking Springs and Kununurra, through to Victoria River in the Northern Territory. There is a single modern collection from the Julia Creek region of Queensland, and one of the types also comes from this area. Occurs in alluvial silts, or black or grey cracking clay, frequently with *Acacia farnesiana*. Flowers Dec. to April. Fig. 2, A–C.

Distinguishing features

Distinct from the other species of *Tribulopis* with 4–5 pairs of leaflets by the lowest pair of leaflets inserted very close to stem and by its glabrous ovary and fruits. Its occurrence on heavy soils may also aid in its recognition.

Specimens examined

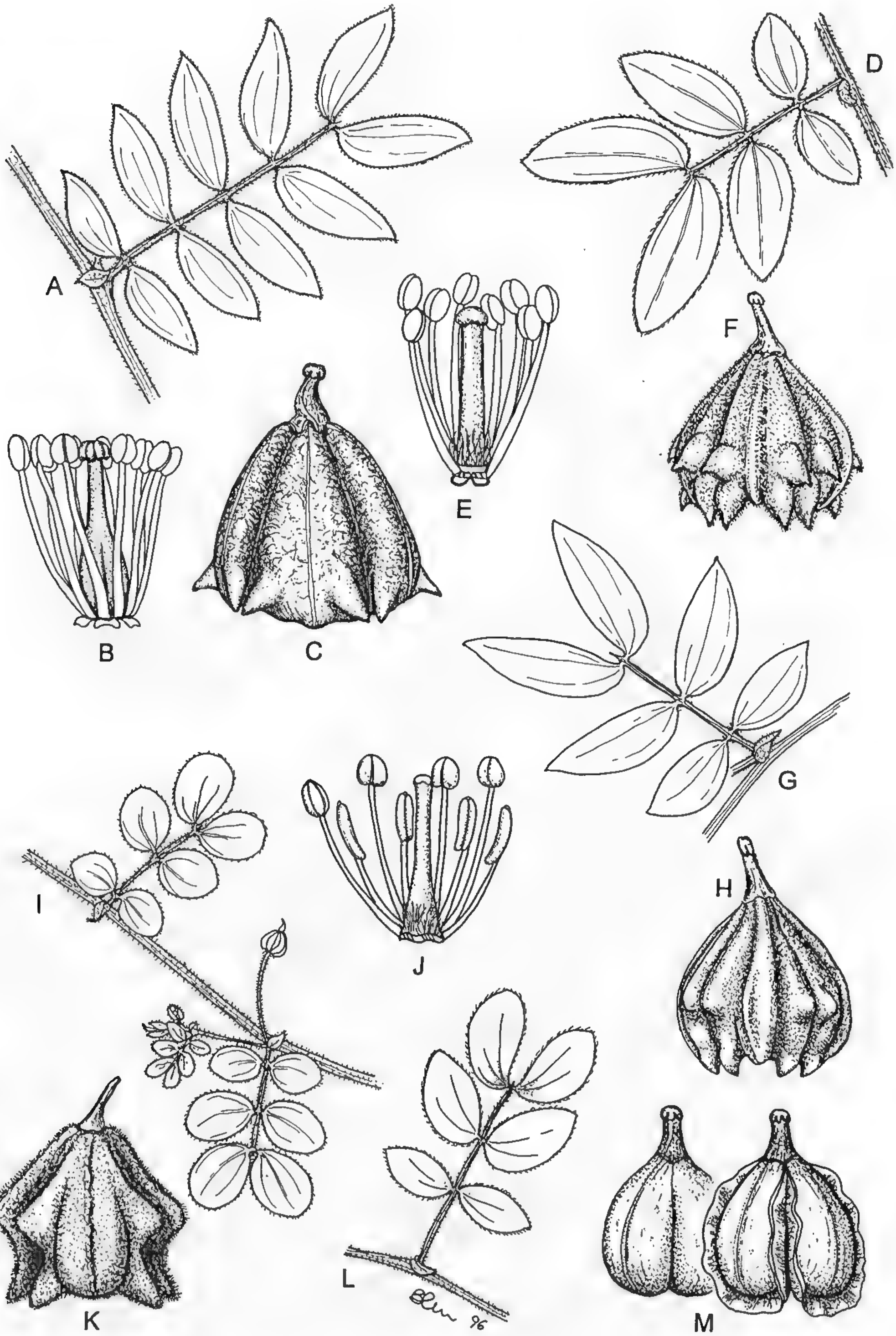
WESTERN AUSTRALIA: Camballin, *J.H. Wickett s.n.* (PERTH); Liveringa, *H.F. Broadbent 592* (PERTH); Carlton Hill Stn, *C. Glover B7-1* (PERTH); Brooking Springs Stn, c. 10 km NE of Fitzroy Crossing, *T.E.H. Aplin et al. 242* (CANB); Kimberley Research Stn, North Bank Diversion Dam, *K.T. Richards 56* (CANB); Carlton Hill Stn near site B7, *C. Glover 142* (CANB).

NORTHERN TERRITORY: 26 km NW of Top Springs roadhouse on Victoria River Downs road, *K.L. Wilson 4751* (NSW).

QUEENSLAND: Cremona Downs Stn, 70 km N of Julia Creek, ii.1989, *A.R. Bird s.n.* (BRI).

6. Tribulopis angustifolia R. Br. in Sturt, *Expedition into Central Australia* 2 *App.* 70 (1849); H. Eichler, *Fl. Central Austral.* 184 (1981); Keighery, *Flora* 172: 331 (1982); Lawrence, *Fl. Kimberley Region* 676 (1992); – *Kallstroemia angustifolia* (R. Br.) Engl. in Engl. & Prantl, *Nat. Pflanzenfam.* 3(4): 88 (1890); – *Tribulus angustifolius* (R. Br.) Benth., *Fl. Austral.* 1: 290 (30 May 1863); Ewart & Davies, *Fl. N. Terr.* 155–156 (1917); Domin, *Biblioth. Bot.* 89: 281 (1926); Specht & Mountford, *Rec. Amer.-Austral. Scientific Exp. Arnhem Land* 247 (1958).

Fig. 2. A–C, ***Tribulopis sessilis***, **A**, leaf (×2), *Glover B7-1;* **B**, flower (×10) with petals removed, showing extrastaminal glands, **C**, fruit, topped by remnant style (×6), both *Broadbent 592.* **D–F**, ***T. solandri***, **D**, leaf (×2), **E**, flower (×8) with petals and one stamen removed, both *Morton 558*; **F**, fruit, topped by remnant style (×8), *S.T. Blake 23485*; **G–H**, ***T. sp. nov Lizard Island***, **G**, leaf (×2), *Batianoff 12123*; **H**, fruit, topped by remnant style (×8), *Fisher & Leckie 105*; **I–K**, ***T. bicolor***, **I**, leaf (×2); **J**, flower (×10) with petals and two stamens removed, both *Solomon 697;* **K**, fruit, topped by persistent style (×8) *Evans 3068*; **L–M**, ***T. homalococca*** var. ***alifer***, **L**, leaf (×2), **M**, fruit, topped by persistent style (×10), both *Wilson 8090*, back fruit var. ***homalococca***, after illustration in Domin protologue


A
B
C
D
E
F
G
H
I
J
K
L
M

Lectotype here designated: *R. Brown 36 [J.J.Bennett number 5218]*, 17–28 Nov. 1802, Island a [Sweers Island], Carpentaria (BM); isolectotypes: K, NSW391138, MEL.

Tribulus angustifolius var. *clementii* Domin, *Biblioth. Bot.* 89: 281 (1926).
Type citation: Nordwest-Australien: zwischen Ashburton - und Yule River, *E. Clement.*
Probable holotype: N.W. Australia, fl. Ashburton et Yule River, s.dat., *E.Clement s.n.* (PR); isotype: K. Both specimens seen in Eichler MS as photographs.

Tribulopis affinis (W. Fitzg.) H. Eichler, *Nuytsia* 5: 177 (24 Oct. 1984); – *Tribulus affinis* W. Fitzg., *J. Proc. Royal Soc. W. Austral.* 3: 157 (1918).
Type citation: Near Derby; Lennard, Barker and King Rivers, *W.V.Fitzgerald.*
Syntypes: Junction of Lennard and Barker Rivers, May 1905, *W.V.Fitzgerald 554* (PERTH, NSW145427); Lennard River, May 1905, *W.V.Fitzgerald 554* (NSW145428); King River, East Kimberley, Oct. 1906, *W.V.Fitzgerald 1681* (PERTH, NSW145429, NSW145430 (NSW specimens lacking Fitzgerald number).

Tribulopis curvicarpa (W. Fitzg.) Keighery, *Flora* 172: 332 (1982); Hj. Eichler, *Nuytsia* 5: 177 (1984), *superfluous combination.*

Kallstroemia curvicarpus (W. Fitzg.)C.Gardner ex Beard, *Descr. Cat. W. Australian Plants* (1965) 53 *nom. inval.* (no full and direct reference to the basionym); – *Tribulus curvicarpus* W. Fitzg., *J. Proc. Royal Soc. W. Austral.* 3: 158 (1918).
Types: Goody Goody, near Derby, *W.V.Fitzgerald 211* (NSW145425, PERTH).

Tribulus leptophyllus F.M. Bailey, *Qld Dept Agric. & Stock. Botany Bull.* 3: 8 (May 1891).
Types: Walsh River, *T.Barclay Miller s.n.* (BM, BRI, K, MEL, all seen in Eichler MS and all apparently annotated by Bailey).

Tribulop[s]is solandri auct non R. Br.: F. Muell., *Fragm.* 1: 47 (1858) p.p. (only as to specimens assigned to *T. angustifolia*); F. Muell., *Pl. Indig. Colony Vict.* 1: 99 (1862) p.p.; Ewart & Davies, *Fl. N. Terr.* 155–156 (1917).

The most widespread of all of the species being found in all three states of northern Australia, but occurring as far south as the Tropic of Capricorn in all of these states. Occurs in sand or sand/clay in a variety of habitats including tussock grassland, Eucalyptus woodlands, levee banks and red sand interdune areas associated with spinifex. It is often recorded after fire. Fig. 1, G–I.

Notes

A very variable species with respect to hair covering, flower size, ornamentation of the cocci, length of the style, size of the fruit and the number of spines on the fruit; this variation is possibly related to the variety of habitats which it occupies. Larger flowered specimens, which appear to be short-lived perennials because of the possession of a tap root are usually found in beach localities or deep sands of the north coast and in the areas north of Katherine; their fruits are often without any spines. Specimens with both median and basal spines are usually to be found in the more southerly part of the distribution. However these differences were not found to be classifiable since there were many specimens showing variation in flower size and presence or absence of spines on the fruit of the one plant. Any future analysis of the variation of this species should also include *T.* aff. *angustifolia* (Mt. Isa) since it may also belong here.

Previous species recognised within this complex, *T. leptophyllus*, *T. affinis* and *T. curvicarpa*, are defined by characters which are extremely variable and the species have not been distinguished here.

- *Tribulopis curvicarpa* applies to specimens with bristly hairs, 4–5 leaflets and the fruitlets hirsute and reticulate on the dorsal surface and with median and basal spines. The name, as has been pointed out by Lawrence (*Flora of the Kimberley Region* p. 676), refers to the curved fruit which develops in all specimens when all but one of the cocci are aborted.
- *Tribulopis affinis* applies to hirsute specimens with 2–5 leaflets, petals shorter than the sepals and the fruitlets prominently reticulate dorsally and lacking any spines. The character of the petals being shorter than the sepals is erroneous for those

syntypes seen but in some other specimens (e.g. *J.Egan* 1890 from DNA) there are mature buds which have split open, revealing the stamens and very short petals; it is difficult to decide whether these are cleistogamous, since some pollen appears to be mature, or whether they will develop into larger flowers.

- *Tribulus leptophyllus* applies to specimens with 2–3 leaflet pairs, small flowers (petals c. 5 mm long) and only half of the stamens with fertile anthers.

Latz & Albrecht (*Latz 11901*) recorded thousands of fruitlets covering a meat-ant nest after fire. Presumably the seeds or the enveloping coat of the fruitlet must produce some attractant to ants.

Distinguishing features

Usually easily distinguishable from any other *Tribulopis* species by the linear to narrowly elliptic leaflets (10–45 mm long), the lowest pair of these inserted well above the stem. Those specimens of *T. angustifolia* where the leaflet number is occasionally reduced to 2, compared with the more usual 4–5, can be distinguished from the *T. pentandra* group (also characterised by narrowly elliptic leaflets) by the 10 fertile stamens in comparison with the 5–7 of the *T. pentandra* group and the more rounded and larger (5–11 mm high) fruits of *T. angustifolia* compared with the distinctly triangular and smaller (up to 4 mm high) fruits of *T. pentandra.*

Selected specimens examined

WESTERN AUSTRALIA: Bobby Creek, 11 km ENE of Beagle Bay, Dampier Pen., W. Kimberley, *B.J. Carter 511* (BRI, PERTH); Hidden Valley, just N of Kununurra, *Hj.Eichler 22483* (AD, CANB, CHR, CONC, LAE, L, MO, MEL, NSW, PERTH, P); Bull Creek, Bungle Bungle N.P., *I.D. Cowie 820* (DNA); 5 miles N of Christmas Creek on RPF[Rabbit Proof Fence], *R.D. Royce 1740* (PERTH); 32 km NW of Goldsworthy, c. 4 km along Great Northern Hwy - Shellborough track, *I.R. Telford 6497 & G. Butler* (CANB).

NORTHERN TERRITORY: Victoria Hwy, Gregory N.P., *I.R. Cowie 2452 & Brocklehurst* (DNA, CANB, PERTH, MEL); Cape Arnhem, *C.R. Dunlop 9689 & Wightman* (DNA); Barkly Hwy, *J. Egan 1890* (DNA); Gove; N of Gwapalina Pt, *J. Egan 2750* (DNA); Fiddlers Lake, Tanami Desert, *P. Latz 11901* (MEL, NT); 108.5 km E of Kintore T/off on main Kintore - Papunya Road, Plot 1194, *G. Leach & MB 1544* (DNA); Calvert River Mouth, *B.G. Thomson 1853* (DNA).

QUEENSLAND: Near junction of Nassau R and Rocky Creek, *V.J. Neldner 3031 & J. Clarkson* (BRI, DNA, MBA, PERTH); Near source of Poison Creek, c. 90 miles N of Hughenden, *S.T. Blake 8529* (BRI); Delta South Station, between Barcaldine and Blackall, *L.S. Smith & S.L. Everist 235* (BRI); 10 km W of Carlo HS, Gregory North District, *C. Mitchell 687* (BRI); 12.5 km NNE of Bowie, on road to Yarrowmere, *E.J. Thompson BUC306 & B.K. Simon* (BRI); 24 km W of Charters Towers on Hughenden Rd, *K.L. Wilson 5598* (CANB, NSW).

7. Tribulopis aff. angustifolia (Mt. Isa)

Prostrate, slender annual herb; stems 20–60 cm long, appressed-pubescent. Leaves with 4–5 pairs of leaflets, the lowest pair inserted well above stem; leaflets narrowly ovate, shortly petiolulate, oblique, shortly acuminate, ciliate, glabrous adaxially, sparsely appressed pubescent abaxially (lower); upper pair erect, 6–10 mm long, 2–3.5 mm wide; lower pairs spreading, similar size. Flowering pedicel 13–24 mm long, upright, fruiting pedicel to 35 mm long, deflexed. Sepals c. 3.5 mm long, glabrous adaxially, sparsely appressed abaxially; margin hyaline. Petals yellow throughout, obovate, 5–7.5 mm long, longer than sepals. Extra-staminal glands 5, intrastaminal glands lacking. Stamens 10, 5 usually shorter, all fertile, at maturity equal to stigma; filaments c. 2 mm long; anthers 0.6–0.8 mm long. Ovary with dense appressed white hairs, 5-lobed; style (including stigma) 1.5–1.8 mm long. Fruit appressed pubescent, of 5, tardily dissociating, fully developed mericarps, each 5–6 mm high, dorsally smooth, with pair of retrorse basal spines and pair of median spines.

Known only by 2 collections from just north of Mt Isa, one from quartzite with *Lophostemon grandiflorus*, the other from scree slopes. Flowering Jan-May.

Distinguishing features

This taxon may represent part of the variation of *T. angustifolia* and further collections may not support its status. However it is distinct from *T. angustifolia* by the hair covering on the ovary, the wider leaflets (almost ovate since the ratio of length to breadth is usually just less than 3:1) and the shorter style.

Specimens examined

QUEENSLAND: 13 km NE of Mt Isa, *P.L. Harris 460* (BRI); Lake Moondarra, NNE of Mt Isa, *K.L. Wilson 5429* (CANB, NSW- 2 sheets).

8. Tribulopis solandri R. Br. in Sturt, *Expedition into Central Australia* 2 *App.* 70 (1849); F. Muell., *Fragm.* 1: 47 (1858) p.p. (excluding specimens assigned to *T. angustifolia*); Keighery, *Flora* 172: 331 (1982); Lawrence, *Fl. Kimberley Region* 678 (1992); – *Tribulus solandri* (R. Br.) F. Muell., *Pl. Indig. Colony Vict.* 1: 99 (1862); Benth., *Fl. Austral.* 1: 290 (1863); F. Muell. *Fragm.* 11: 30 (1878); F.M. Bailey, *Queensl. Fl.* 1: 173 (1899); Domin, *Biblioth. Bot.* 89: 281 (1926; – *Tribulus solandri* var. *typicus* Domin, *Biblioth. Bot.* 89: 281 (1926); – *Kallstroemia solandri* (R. Br.) Engl. in Engl. & Prantl, *Nat. Pflanzenfam.* 3(4): 88 (1890).

Type collections: In ora orientali intratropica Novae Hollandiae prope Endeavour River, 1770, *J.Banks & D.Solander s.n.* (BM, BRI (ex BM), NSW133284 (ex BM) - all seen as photographs in Eichler collection of protologues. Specimens are annotated as "Tribulus minor Sol.").

Found only on Cape York Peninsula. Occurs in sands, associated with beaches and rivers, and also in basalt and granite. Flowering March to May. Fig. 2, D–F.

Notes

The name applies to the slender herb found in the sands of the Cook region of Queensland. More robust specimens from Western Australia which have been included within the species in the past approach *T. bicolor* more closely and indicate a much closer relationship to that species than the present taxonomy indicates. From a study of the specimens it seems likely that *T. bicolor* should perhaps be included under *T. solandri* but the two have been maintained here since they have not been seen in the field and there are possibly other characters to be found.

The darker centre of the flower of *T. bicolor* is not to be found in all specimens and in any case cannot be recognised on dry material; the tendency for the ovary of *T. bicolor* to be glabrous and clearly seated upon a ring of nectariferous tissue breaks down in some specimens where the ovary is sparsely to densely white pubescent, with the hairs appressed or erect. In these specimens it is difficult to make out what is happening with the nectariferous tissue, although in *T. solandri* the tissue seems to be present as 5 distinct glands. The hairs on the ovary of *T. solandri* are finer and apparently in 5 bundles compared with the stiff, erect hairs of some of the Western Australian specimens.

Mueller (1878) included *T. angustifolia* within *T. solandri.*

Distinguishing features

Within the groups of species which have 3 leaflet pairs, *T. solandri* can be distinguished from *T. homalococca* by its paired basal and median outgrowths on the fruit (lacking in *T.*

homalococca) and from *T. bicolor* by its elliptic to obovate leaflets up to 18 mm long (cf. 6–9.5 mm long in *T. bicolor*) and by its 10 fertile stamens whereas up to 6 may be staminodal (long linear anthers) in *T. bicolor*. However *T. solandri* and *T. bicolor* (q.v.) may prove not to be sufficiently distinct to both warrant species status.

Specimens examined

QUEENSLAND: Quarantine Bay near Cooktown, *S.T. Blake 23485* (BRI); Twelve Mile Lagoon area, Lakefield N.P., *A.R. Bean 5528 & P. Forster* (BRI, CANB); Weipa, Nanam Beach on Mission River, *A. Morton 558* (BRI).

9. Tribulopis aff. solandri (Lizard Island)

Prostrate, slender annual herb; stems 20–60 cm long, usually glabrous, sometimes with appressed, curled white hairs in young parts. Leaves with 3 pairs of leaflets, the lowest pair clearly petiolate; leaflets ovate or obovate, shortly petiolulate, oblique, acute or shortly acuminate, glabrous adaxially and abaxially (lower), upper pair suberect, lower spreading, to 11 mm long, to 5.5 mm wide, lowest pair smaller. Flowering pedicel 3.5–6 mm long, upright, fruiting pedicel 7–15 mm long, deflexed. Sepals 2.6–3.4 mm long, glabrous adaxially(inner), sparsely white-appressed abaxially (outer); margin hyaline. Petals yellow throughout, obovate, 5.5–6(-8.4) mm long, longer than sepals. Extra-staminal glands 5, intrastaminal glands 5 or sinuate ring. Stamens 10, all fertile or up to 6 staminodal, at maturity equal to stigma; filaments 1.8–2.5(-3) mm long; anthers 0.4–0.7 mm long if fertile, 1.1–1.5 mm long if staminodal. Ovary glabrous, ?not seated on intrastaminal ring; style (including stigma) 1.5–2 mm long. Fruit glabrous, of 4–5, tardily dissociating, fully developed mericarps, each 3–3.5 mm high, with pair of divergent median and retrorse basal bumps dorsally. Fig. 2, G–H.

Restricted to Lizard and Flinders Islands off the coast of Cape Yorke Peninsula. Occurs in coastal sands, usually amongst grasses such as *Cyperus* and *Schizachyrium* below *Casuarina equisetifolia*. Flowers April–Aug.

Distinguishing features

Possibly only a glabrous form of *T. solandri,* except that the pedicels tend to be shorter and the dorsal surface of the fruit is more rounded and only develops bumps medianally and basally, rather than spines. Further collections and field work are needed to clarify its status.

Specimens examined

QUEENSLAND: Lizard Island, Casuarina Beach, *G.N. Batianoff 12123* (BRI, CANB, DNA, BISH, K, NSW); Flinders Island, c. 7 km N of Bathurst Head in southern end of Princess Charlotte Bay, *J.R. Clarkson 2267* (BRI); Flinders Island, *J.A. Elsol 753 & T.D. Stanley* (BRI); Lizard Island, *N. Byrnes 3142* (BRI); Lizard Island, N end of Research Beach, *N. Fisher 105 & H. Leckie* (CANB).

10. Tribulopis homalococca (Domin)R.M. Barker, *comb. nov.*

Tribulus homalococcus Domin, *Biblioth. Bot.* 89: 280 (1926), t. 37, fig. 2–5.

Syntypes: K.Domin 5503, Feb.1910, in collibus calcareis apud opp. Chillagoe (PR); *K.Domin 5502*, Feb.1910, in collibus calcareis Lions Head Bluff dictis apud opp. Chillagoe (PR) – seen as photographs in Eichler collection of protologues.

Both varieties of *T. homalococca* have only been collected from the Chillagoe area of Queensland. Fig. 2, L–M.

Further collections of this species are desirable to attain an understanding of its variability and relationship to other species of *Tribulopis* and any collectors who find themselves in the Chillagoe area in February-March are requested to look out for this

species. The illustrations accompanying the type descriptions (see synonymy above) should prove helpful to anyone searching for the species.

Distinguishing features

T. homalococcus can be distinguished amongst the species with 3 pairs of ovate to obovate leaflets by the appressed, curled white hairs in young parts, by the glabrous ovary and by its dorsally rounded fruits lacking any outgrowths, except a basal semicircular wing in the case of var. *alifer*.

Key to varieties of *T. homalococca*

Mericarps lacking wings, glabrous .... a. var. ***homalococca***
Mericarps with basal semicircular wings, covered with short erect pubescence .... b. var. ***alifer***

10a. Tribulopis homalococca Domin var. **homalococca**

Tribulus homalococcus var. *typicus* Domin, *Biblioth. Bot.* 89: 280 (Oct. 1926) *nom. inval.* (type variety).

Fruit rounded dorsally, lacking wings, spines or any outgrowths, glabrous.

As stated above, the only collection known is that of the type from the Chillagoe area.

Specimens examined

None seen. The Hubbard & Winders collection cited below may belong here since it does not possess mature fruit, but there are indications on the young fruits that the wing characteristic of var. *alifer* is developing.

Distinguishing features

The fruits of *Tribulopis homalococca* var. *homalococca* would appear to be unique in the genus by their lack of any outgrowths and their rounded smooth nature.

No authentic specimens of *Tribulopis homalococca* var. *homalococca* have been seen except the type, and even these, only as photographs in the Eichler manuscripts.

10b. Tribulopis homalococca var. **alifer** (Domin)R.M. Barker, *comb. nov.*

Tribulus homalococcus var. *alifer* Domin, *Biblioth. Bot.* 89: 280 (1926) t. 37, fig. 6.

Holotype: Bei Chillagoe, Feb. 1910, *K.Domin 5501* (PR), seen as photograph in Eichler collection of protologues.

Fruit rounded dorsally, with basal semicircular wing on each of the fruitlets, covered with short dense erect fine pubescence. Fig. 2, L–M.

Known only from the Chillagoe area of North Queensland. Occurs on lower open slopes of limestone bluffs within grasses in open Eucalyptus forest. Flowers Jan.-Feb.

Wilson's notes on her collection indicate that the fruits of this taxon were pale pink and somewhat fleshy.

The Hubbard & Winders collection of this taxon was annotated by Eichler with the name *Tribulopis homalococca* (Domin)H. Eichler, indicating that he intended to make this combination.

Distinguishing features

As for *T. homalococca* but each fruitlet has a wing along the boundary of the dorsal and lateral walls.

Specimens examined

QUEENSLAND: Chillagoe, *C.E. Hubbard & C.W. Winders 6751* (BRI, K); 2 km along Royal Arch road from Gulf Development Rd (W of Chillagoe), *K.L. Wilson 8090, J. Clarkson & S. Jacobs* (BRI, NSW)

Acknowledgments

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Denzel Murfet made a special effort to collect *Tribulopis* while based at Borroloola in the Northern Territory and I am indebted to him for his comments on the dispersal of the fruitlets.

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DESCRIPTIONS OF THREE CULTIVARS IN *WATSONIA* (IRIDACEAE)

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Abstract

Many named cultivars of *Watsonia* were grown in Australia before 1940, but are now lost due to their neglect in horticulture and the absence of formal descriptions. The *Watsonia* cultivars **'Jessie'**, **'Leng'** and **'SuiLan'** are described and the Cronin hybrids discussed.

Introduction

The systematic breeding of *Watsonia* for ornamental gardens and the cut-flower trade did not begin until the early 20th century and was carried out mainly in Australia and California. On the other hand, gardeners in South Africa used a much wider range of *Watsonia* species and unnamed natural hybrids but few named cultivars (Eliovson, 1955; 1968).

Between about 1920 and 1940 hybrid *Watsonia* cultivars had a brief period of popularity in Australia; the most famous were produced by John Cronin, who was Director of the Royal Botanic Gardens in Melbourne from 1909–1923. They were known as the Cronin hybrids, or the Commonwealth hybrids because the first ones released were named after Australian capital cities.

No documentation of Cronin's work remains at the Melbourne Botanic Gardens (R. Spencer, pers. comm.), although some of the unlabelled hybrids growing there may be remnants of his stock. According to Pescott (1926), the Cronin hybrids were clones selected from F_2 swarms bred from *Watsonia rosea, W. O'Brieni, W. altroides* (sic) and *W. meriana*; these may be referred respectively to pink-flowered *W. borbonica* (Pourret)Goldblatt subsp. *ardernei* (Sander)Goldblatt and its albino variants, *W. aletroides* (Burm.f.)Ker Gawler and *W. meriana* (L.)Miller var. *meriana. Watsonia coccinea* Herbert ex Baker is also likely to have contributed, as it has been cultivated in Australia since the mid-19th century and has been confused with both *W. aletroides* (eg. by Montague, 1930) and with *W. meriana* (eg. by Cooke, 1986). The known Cronin hybrids are listed in Appendix A; all were spring-flowering pla!nts with corms dormant through the summer, as were the parent species.

Several other breeders in Melbourne and Sydney were working independently with the same species, which all have a haploid chromosome number of 9 (Goldblatt, 1989) and are interfertile (Horn, 1962). Named cultivars known to have come from this source are listed in Appendix B. However, other cultivars derived from the evergreen summer-flowering *Watsonia* species or from *W. marginata* (L.f.) Ker Gawler have been omitted from the present publication.

Breeders all aimed to produce a wider range of colours, including two-toned or three-toned flowers; increase flower size; produce a denser inflorescence by increasing branching; lengthen the flowering period into the early spring period, and adapt the plants to a wider range of climates including the hot humid spring-summer conditions of the east coast (Cowlishaw, 1928).

Flower shapes were classified (Pescott, 1926) as **star-shaped,** having a stellate limb with lanceolate, acute lobes, and **broad-petal** or imbricated in which the lobes were broadened, often resulting in undulate margins and obtuse apices.

Cultivars may differ from each other more subtly than do species of the same genus. Ornamentals are selected for combinations of colour, form and performance that are difficult to describe objectively; if of hybrid origin they usually differ from both parent species in many quantitative characters. Their unambiguous description may therefore require as much detail as a species description. However, the cultivar names in Appendices A and B were published in trade publications with only a few words about flower colour and size of plant.

Watsonia became unfashionable in post-war Australian gardens; Hitchmough (1989) and Macoboy (1991) suggest that most of the old cultivars have been lost, inasmuch as the correct application of their names is now only conjectural. A search of garden literature confirmed that the few *Watsonia* cultivars now on the market are sold by flower colour or under trade names like 'Tivoli Pink' and 'Fairy White' that were unknown 30 years ago. In the absence of standard specimens, adequate descriptions or plants of known provenance, the old names must be treated as *nomina nuda* whose correct application cannot be established.

This paper is the first in a series intended to name and describe some *Watsonia* cultivars worth perpetuating in horticulture. It is likely that some of these were distributed under other names in the period 1920-1940.

Each description is based on a clone propagated from a single corm and grown under open garden conditions at sea-level near Adelaide. Measurements of the flowers are based on fresh specimens; in dried material the perianth shrinks and often changes in proportion. The basal part of the perianth tube is the narrow section from the top of the ovary to the insertion of the stamens; the distal part is measured from the stamen insertion to the bases of the perianth lobes.

Colour photographs of the three cultivars may be found at:

http://www.ozemail.com.au/~davcooke/watsonia.htm Flower colours were matched to the Royal Horticultural Society Colour Chart, 3rd edn (1995).

Descriptions

***Watsonia* 'Leng'** D.A.Cooke, *cult.nov.*

Standard specimen: Cultivated at Warradale, South Australia, October 1997, *D.A. Cooke 931* AD, MEL.

Herb 120–150 cm tall. Leaves 5–7, 17–30 mm wide, to 70 cm long, pale glaucous green; midvein obscure, margins unthickened. Axillary cormils absent. Spike with 16–22 flowers (about 5–6 open at once) loosely spaced; 3–5 side branches, sometimes secondarily branched; axis glaucous green at first but becoming flushed purple. Outer bract 14–21 mm long, acute, slightly shorter than the internode, herbaceous but purplish-tinted below, scarious distally. Inner bract longer or slightly shorter, bifid. Perianth a cool lilac-mauve (RHS 80B) on edges of lobes shading gradually to pale mauve (RHS 80D) on tube; midline of lobes with a diffuse cream line on outside. Tube 36–42 mm long, the basal part pale 10–13 mm long, to 2 mm wide, the distal part funnel-shaped, at first horizontal but becoming decurved, 24–30 mm long, 8–10 mm wide at mouth. Lobes oblanceolate, flared at right angles to tube or slightly recurved; inner lobes 37–41 mm long, 17–20 mm wide, lanceolate, subacute with !undulate margins; outer lobes 33–38 mm long, 13–17 mm wide, obtuse, apiculate with flat margins. Stamens unilateral, arcuate; anthers deflexed below style, anthers 12–13 mm long, dark purple. Pollen dark purple. Style branches not exceeding the anthers, once-dichotomous. Capsule clavate, acute, 27–30 mm long. Seeds brown with two unequal stramineous wings, 14–18 mm long overall. Flowers in mid-September to October.

Provenance: Corm collected from a population of garden escapes along a roadside at Longwood, Adelaide Hills, 1995.

This cultivar is likely to have been derived by selection from *W. borbonica* subsp. *ardernei*, with no characters suggesting contribution from other species. It is differentiated from other accessions of subsp. *ardernei* by the loose spike of pale lilac-mauve flowers with larger overlapping oblanceolate perianth lobes whose weight causes the tube to bend downwards. It is self-sterile, but produces fertile seed when pollinated by *W. borbonica* subsp. *ardernei* or *W.* 'Jessie'.

***Watsonia* 'SuiLan'** D.A.Cooke, *cult.nov.*

Standard specimen: Cultivated at Warradale, South Australia, October 1997, *D.A. Cooke 932* AD, MEL.

Herb 100–130 cm tall. Leaves 5–7, 18–34 mm wide, to 67 cm long; slightly glaucous green; midvein obscure, margins unthickened. Axillary cormils absent. Spike with 17–24 flowers (about 6–7 open at once) overlapping and congested, plus 3–4 side branches; axis green. Bracts herbaceous at base, distal two-thirds maroon-scarious. Outer bract 16–20 mm long, barely longer than the internode. Inner bract subequal to outer, emarginate to deeply bifid. Perianth magenta in bud, opening magenta-pink RHS 67C, shading into a darker warm pink RHS 57C on outside of tube but a paler warm pink RHS 55B inside; small darker magenta mark at base of each lobe. Tube 37–41 mm long, the distal part funnel-shaped, ascending to horizontal, 20–25 mm long, 10–12 mm wide at mouth. Lobes flared at right angles to tube or slightly recurved, the outer oblanceolate, 32–40 mm long, 14–18 mm wide, obtuse to apiculate, with flat margins; the inner obovate, 36–43 mm long, 18–23 mm wide, obtuse to subacute, with undulate margins. Stamens unilateral, arcuate; anthers deflexed below style, 11–13 mm long, purple. Pollen dark purple. Style branches not exceeding anthers, once-dichotomous. Capsules obovoid, obtuse, 25–28 mm long. Seeds brown with two short unequal stramineous wings, 7–11 mm long overall. Flowers mid-October to November.

Provenance: Corm collected from a population of garden escapes along a roadside at Longwood, Adelaide Hills, 1995.

Watsonia 'SuiLan' is recognisable by its congested spike of magenta-pink flowers, opening from darker magenta buds, with a warmer tone in the centre. It appears to be a sophisticated garden hybrid resembling *W. borbonica* subsp. *ardernei* in the general form of the flowers and bracts but with the addition of a yellow floral pigment from a species such as *W. meriana* to produce the warm pink tones. It is self-sterile, but produces fertile seed when pollinated by *W. borbonica* subsp. *ardernei.*

***Watsonia* 'Jessie'** D.A.Cooke, *cult.nov.*

Standard specimen: Cultivated at Warradale, South Australia, October 1997, *D.A. Cooke 933* AD, MEL.

Herb 90–120 cm tall. Leaves 30–70 cm long, 1–3 cm wide, pale green; midveins obscure, margins unthickened. Solitary cormils often produced in lower leaf axils. Spike with 12–20 flowers on main axis (5–6 open at once), overlapping, plus 3–5 side branches, the lower ones sometimes secondarily branched; axis flushed purple. Outer bract 20–26 mm long, acute, subequal to the internode, at anthesis wholly herbaceous but pink near the apex, soon becoming half scarious. Inner bract subequal, subacute, emarginate to entire. Perianth tube 35–39 mm long, a deep warm pink (RHS 50B) externally, the distal part funnel-shaped, almost horizontal, 20–23 mm long, 8–10 mm wide at mouth. Perianth lobes elliptic, flared at right angles to tube or the dorsal lobe slightly hooded; uniformly pale flesh pink (RHS 52D) with a deeper warm pink streak from near the centre extending down inside the tube;

margins flat, apices acute. Outer lobes 30–33 mm long, 11–13 mm wide; inner 32–36 mm long, 13!–16 mm wide. Stamens unilateral, arcuate; anthers deflexed below style, 9–10 mm long, purple. Pollen light mauve. Style branches exserted far beyond the anthers, once- or twice-dichotomous. Capsule clavate, acute, 30–36 mm long. Seeds red-brown with two unequal stramineous wings, 12–16 mm long overall. Flowers mid September to October.

Watsonia 'Jessie' is recognisable by its dense spike, star-shaped perianth in two tones of warm pink and the long style extending beyond the anthers. It appears to be derived from *W. borbonica* (acute floral bracts, perianth lobes widely flared and almost as long as tube) and *W. meriana* (acute perianth lobes, flower colour, exserted style). The axillary cormils often occur in the latter species (Cooke, 1998). It is self-sterile, but produces fertile seed when pollinated by *W. borbonica* subsp. *ardernei.*

Superficially similar plants are widely grown in Australian gardens, and may all be one clone. Such plants have been illustrated as *W. pillansii* by Cheers (1997) and as *W. beatricis* by Macoboy (1991). *W. pillansii* L.Bolus is readily distinguished from this cultivar by its evergreen habit, unbranched flower spikes produced in summer, and orange to vermilion perianth with a cylindrical tube longer than the limb. *W. beatricis* J.Mathews & L.Bolus is a synonym (Goldblatt, 1989).

W. 'Jessie' may be one of the original Cronin hybrids, but there is insufficient information to refer it to any of them. *W.* 'Melbourne' and *W.* 'Australia' approached it in colour (Warner, 1926) but the former was described as dwarf and the latter had flowers of the 'imbricated' type (Montague, 1930).

Another clone seen in cultivation differs from *W.* 'Jessie' only in having an erect perianth tube no more than 30 mm long with the limb of the perianth consequently crowded against the stem; this plant is excluded from the above description.

APPENDIX A

JOHN CRONIN'S COMMONWEALTH HYBRIDS

***Watsonia* 'Adelaide'** Dwarf, early flowering. Spike with few side-branches. Flowers salmon scarlet (Brunning, 1924), orange-red (Warner, 1924); also described as orange-scarlet with a lighter throat (Anon, 1930), or orange (Brunning, 1934). Released circa 1923 by Warner & Son, Victoria.
***Watsonia* 'Albury'** Flowers buff with red throat (Anon, 1930). Released by Ormond Plant Farm, Victoria in 1930.
***Watsonia* 'Australia'** Flowers large, with imbricated lobes, vieux rose and soft pink (Warner, 1926; Montague, 1930). Released by Warner & Son circa 1924.
***Watsonia* 'Ballarat'** Flowers pale blush pink (Warner, 1926; Montague, 1930). Free-flowering. Released circa 1924 by Warner & Son.
***Watsonia* 'Brighton'** Flowers "purple in a bright and pleasing shade" (Anon, 1930). Released by Ormond Plant Farm in 1930.
***Watsonia* 'Brisbane'** Flowers purple (Warner, 1926). Released by Warner & Son circa 1926; however, the name was very soon misapplied to a plant with crimson scarlet flowers (Anon, 1930) and to another with flesh pink flowers (Cowlishaw, 1928; Montague, 1930) which was later distributed under this name by Law Somner.
***Watsonia* 'Canberra'** Flowers a deep rosy-mauve; still extant in New Zealand (Redgrove, 1991). Not mentioned in any Australian source seen, but the name strongly suggests its inclusion on this list.
***Watsonia* 'Caulfield'** Flowers large, pale pink (Anon, 1930). Released by Ormond Plant Farm in 1930.
***Watsonia* 'Clunes'** Flowers white with a mauve throat (Anon, 1930). Released by Ormond Plant Farm in 1930.
***Watsonia* 'Croydon'** Flowers pale mauve, darker shaded in the tube (Anon, 1930). Released by Ormond Plant Farm in 1930.
***Watsonia* 'Hobart'** Released circa 1924 by Warner & Son, described as "tall late white with well-shaped round flowers" (Warner, 1924). Pescott (1926) confirms that the flowers were pure white; but the name was later misapplied to a plant with soft rose-pink flowers (Montague, 1930) which was distributed under this name by Law Somner.

Watsonia **'Lock'** Flowers very large with long tube, bright pink (Anon, 1930). Released by Ormond Plant Farm in 1930.
Watsonia **'Lorne'** Flowers rosy pink, darker shaded in the throat (Anon, 1930). Released by Ormond Plant Farm in 1930.
Watsonia **'Malvern'** Flowers pale heliotrope (Anon, 1930). Released by Ormond Plant Farm in 1930.
Watsonia **'Melbourne'** Dwarf. Flowers large, described as "shell pink" (Brunning, 1924), salmon-pink (Warner, 1924; Pescott, 1926; Cowlishaw, 1928), buff salmon (Anon, 1933) or buff salmon shaded darker in centre (Yates, 1936). Released circa 1923 by Warner & Son.
Watsonia **'Perth'** Flowers rosy purple (Warner, 1926), described also (Anon, 1933) as magenta. Released circa 1924 by Warner & Son.
Watsonia **'Portland'** Flowers pale salmon-pink (Anon, 1930). Released by Ormond Plant Farm in 1930.
Watsonia **'Queenstown'** Dwarf. Flowers lilac mauve (Warner, 1926). Released circa 1925 by Warner & Son.
Watsonia **'Sale'** Flowers pale salmon-pink, darker shaded on the exterior (Anon, 1930). Released by Ormond Plant Farm in 1930.
Watsonia **'Sydney'** Very tall with many long laterals. Flowers large, wide open, variously described as deep mauve (Brunning, 1924), mauve-pink (Warner, 1926), lilac-pink (Cowlishaw, 1928) or two-toned, deep mauve with a deeper mauve tube (Anon, 1930). Released circa 1923 by Warner & Son and sold by Yates in the 30s; however, the name was soon misapplied to another cultivar with ruby red flowers (Montague, 1930; Anon. 1933).
Watsonia **'Victoria'** Tall. Flowers vieux rose, with long tube (Anon, 1930). Released by Ormond Plant Farm in 1930.
Watsonia **'White Australia'** Flowers large, white with very faint pink veining (Anon, 1926); perianth lobes "prettily waved" (Anon, 1930), ie undulate. Flowers were said by both sources to be semi-double; this may mean that the lobes were very broad and even more imbricate than in cultivars such as 'Clarendon Pearl'. First exhibited at Garden Week, Melbourne, in 1925.

APPENDIX B

OTHER AUSTRALIAN HYBRIDS PRE 1940

Watsonia **'Avalon'** Flowers tricoloured, a pale pink but shading to mauve and salmon (Montague, 1930; Brunning, 1934).
Watsonia **'Beauty'** Flowers very pale pink (Montague, 1930; Brunning, 1934). Renascent, spring-flowering. Bred in Sydney in the 1920s (Anon, 1939).
Watsonia **'Clarendon Pearl'** Tall. Flowers large, white with a waxy appearance, lobes broad with undulate margins (Montague, 1930).
Watsonia **'Corallina'** Flowering in late spring. Flowers almost stellate due to the lanceolate acute perianth lobes narrower than in most hybrids. Colour was described as "coral chrome shade, with a touch of salmon" (Montague, 1930) or "chocolate-chrome" (Brunning, 1934).
Watsonia **'Eunice Hunt'** Late spring-flowering. Tall. Flowers salmon-apricot (Montague, 1930; Brunning, 1934).
Watsonia **'Geisha'** Flowers rosy-pink shaded with mauve (Anon, 1930). Released by Ormond Plant Farm in 1930.
Watsonia **'Holloway's Giant White'** Flowers large, pure white (Anon, 1938). Marketed by Yates.
Watsonia **'Lady Fawkes'** Flowers described as orange-red (Cowlishaw, 1928) or salmon-red (Montague, 1930). Bred in Sydney in the early 1920s and marketed by Yates in 1930s.
Watsonia **'Lesley Carson'** Flowers salmon-pink (Brunning, 1939). Bred in Queensland, probably in the 1930s.
Watsonia **'Maitland'** Late spring-flowering; tall. Flowers large, open, "crushed strawberry" colour (Montague, 1930; Anon, 1939). Marketed by Yates in the 1930s.
Watsonia **'Mauveen'** Tall. Flowers large, deep mauve (Montague, 1930; Brunning, 1934).
Watsonia **'Montague's Pink'** Flowers shell pink (Anon, 1939). Bred by Philip Montague at Frankston, Victoria, and released in autumn 1937.
Watsonia **'Multiflora'** Pale-rose flowers appearing early in spring. Also called "fulgens" by Montague (1930).
Watsonia **'Narrabeen'** Flowers deep salmon pink (Montague, 1930). Bred in Sydney in the 1920s and marketed by Yates in the 1930s.
Watsonia **'Netta'** Flowers clear soft salmon-pink (Montague, 1930).
Watsonia **'Novelty'** Flowers nearly yellow (Montague, 1930).
Watsonia **'Peach Blossom'** Flowers peach-blossom pink (Montague, 1930).
Watsonia **'Peach Blow'** Flowers pale pink (Montague, 1930). Bred in the late 1920s.
Watsonia **'Perfection'** Released by Brunning; flowers pale pink (Brunning, 1918).
Watsonia **'Pink Perle'** [Pink Pearl] Flowers pale pink, described as "pearly pink" (Montague, 1930).
Watsonia **'Rosa Holloway'** [Rose Holloway] Flowers large, pale pink (Montague, 1930).
Watsonia **'Rose Perle'** Flower colour deeper than 'Pink Perle' (Montague, 1930), deep rose (Brunning, 1934).
Watsonia **'Ruby'** Flowers a clear amethyst ruby colour (Anon., 1922; Brunning, 1924; Montague, 1930).
Watsonia **'Salmonette'** Tall. Flowers pale salmon pink (Montague, 1930; Brunning, 1934).
Watsonia **'Unique'** Dwarf. Flowers heliotrope, each lobe with a darker stripe (Brunning, 1918; 1924).
Watsonia **'White Queen'** Flowers white. Bred in Queensland (Anon, 1936), and marketed by Yates.

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SENNA PHYLLODINEA A NEW COMBINATION IN *SENNA* (CAESALPINIACEAE)

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Abstract

The combination *Senna phyllodinea* (R. Br.)Symon is made to facilitate the use of the name for those who wish to distinguish it from *Senna artemisioides* ssp. *petiolaris*.

Introduction

The presence of agamospermy, polyploidy and hybridity (Randell 1970) has resulted in a bewildering array of morphological forms in *Senna* in our arid areas. The discovery of abundant polyembryony (Symon 1956) led Randell (1970) to examine its causes and with this new understanding to present a new taxonomic account of the genus in Australia (Randell 1988, 1989, 1990).

The division of the genus *Cassia* L. into three genera *Cassia* L. s.str., *Senna* Miller and *Chamaecrista* Moench has been widely accepted. It is almost solely in Australia in *Senna* ser. Subverrucosae that the taxonomic problems are acute. Randell (1989) has grouped the variants under three core taxa, *S. glutinosa*, *S. cardiosperma* and *S. artemisioides*, and one can agree with much of this grouping with some particular misgivings.

A problem

Under *S. artemisioides* ssp. *petiolaris* Randell has grouped all the variants that possess a flattened petiole. Within this grouping are three widespread entities that may be summarised as follows:-

1. A form with relatively broad phyllodes, green in aspect, straight or slightly curved, pubescent with minute appressed hairs, the lamina readily visible, glabrescent, sometimes pruinose, often with generally short, flattened, terminal leaflets. The pods are (6-) 7 (-9) mm wide, straight or slightly curved.

2. A form with narrower phyllodes, green in aspect, straight or weakly curved, sparsely pubescent with minute hairs and with longer linear or near terete leaflets. The pods are (7-) 8 (-9) mm wide, straight or nearly so. This form has numerous variants and separation from the first is often difficult.

3. A form with phyllodes that are generally falcate, lack terminal leaflets, are densely appressed sericeous tomentose, the lamina only visible on old weathered phyllodes. The pods are 10–13 mm wide and are strongly curved to form one third to half a circle.

In contrast to the previous two forms, intermediates between this and the other taxa of *Senna* are rare. Amongst the numerous sheets of '*petiolaris*' s.l. at AD herbarium the following three might be considered intermediates: *Hilton 1382*, The Frome plain, with narrow curved phyllodes and narrow pods; *Robinson 118*, Glenorchy Station, with densely tomentose phyllodes but with rare lateral leaflets (no pods) and *Badman 132*, Algebuckina, with narrow phyllodes and long terminal leaflets (no pods).

These few intermediates are in marked contrast to the numerous intermediates found in the first two listed above and which have made separation of them so difficult. In addition

the last form is generally ecologically separated and is found in some of the most extreme environments of the Lake Eyre basin.

In view of the reliable features separating this taxon the following new combination is proposed.

Senna phyllodinea (R. Br.)Symon, *comb. nov.*

Basionym: *Cassia phyllodinea* R. Br. in C. Sturt, 2(1849) *Botanical Appendix* 78. "In Herbario D. Sturt specimen exstat nulla stationis ant loci indicatione, sed eandem speciem ad fundum sinus Spencer's Gulf dicti in sterilibus apricis anno 1802 legi". Relevant specimens are at BM, K, E and MEL and of these Randell (1989) has selected the lectotype, "R. Brown [4253] 'Inlet XII, South Coast in arenos steril versus montes' at the BM with isolectotypes at MEL, E, K.

A woody bush shrub, commonly 1.5 × 1.5 m, spreading, often somewhat flat topped. Bark grey becoming dark and rough. Phyllodes falcate, hoary with dense, appressed, silvery hairs with leaflets only in juvenile phase. Flowers not distinctive from *S. artemisioides*. Pods to 13 mm wide (broader than *S. artemisioides*) and curved to 1/3 to 1/2 of a circle.

S. phyllodinea is found on stony landscapes in the Lake Eyre basin in South Australia and extends to SW Queensland and NW New South Wales. It also occurs in the Northern Territory north and east of the Simpson desert.

This account was completed before the revision of *Senna* by Randell & Barlow appeared in Volume 12 of the *Flora of Australia*. However, that does not persuade me to change the proposal above.

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EUCALYPTUS SPLENDENS SUBSP. *ARCANA* (MYRTACEAE) AN ENDANGERED NEW SUBSPECIES ENDEMIC TO SOUTH AUSTRALIA

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Abstract

E. splendens Rule subsp. ***arcana*** Nicolle & Brooker, a new subspecies from south of Millicent in South Australia is described. It differs from *E. splendens* subsp. *splendens* in its consistently low, scraggy habit; larger, slightly crenulate juvenile leaves; larger, sessile buds and fruits and the obtuse operculum. *E. splendens* subsp. *arcana* is endangered, with a very restricted natural occurrence.

Introduction

This new taxon was first brought to our attention by Neville Bonney of Millicent, on whose property the only known populations of *E. splendens* subsp. *arcana* occur. The taxon was first seen by one of us (M.I.H.B.) in January 1986, but subsequent collections and field survey have not followed until relatively recently. The plants have some superficial resemblance to *E. viminalis* subsp. *cygnetensis* Boomsma, however, the morphology of juvenile leaves and buds indicate a relationship to *E. aromaphloia* and related taxa, including *E. splendens*. The new subspecies is of very restricted natural distribution and despite repeated searches for more populations, none has been found.

Eucalyptus splendens Rule subsp. **arcana** Nicolle & Brooker, *subsp. nov.*

Eucalypto splendenti affinis a qua habitu depauperato, foliis juvenilibus majoribus ellipticis integris vel leviter crenulatis; alabastris sessilibus ovoideis operculo obtuso hypanthio aequali vel breviore; fructibus majoribus sessilibus et habitatione calcarea differt.

Typus: SOUTH AUSTRALIA: South-eastern Region: East of Carpenter Rocks township, 26 February 1997, *D. Nicolle 1978* (holo: AD; iso: CANB, NSW, MEL, BRI, HO, K) Fig. 1).

Low scraggy *tree*, sometimes several-stemmed, 2–6 metres tall. Rough bark persistent to 30–80 mm diameter branchlets, rough, fibrous and moderately deeply longitudinally fissured on larger stems, grey to grey-brown; bark thinner, flaky and breaking into shallow longitudinal fissures on smaller stems, sometimes conspicuously tessellated, light grey over red-brown, then smooth above, grey over cream, decorticating in ribbons. Lignotubers present. Pith glands absent. *Cotyledons* bilobed; seedling leaves opposite for 4–12 pairs then alternating, sessile for > 12 pairs, broad-lanceolate, 45–112 mm long by 10–55 mm wide, green, glossy, discolorous. Juvenile stems square in transverse section. All structures non-pruinose. *Adult leaves* alternating, petiolate, lanceolate, sometimes falcate, 80–120 mm long, 12–35 mm wide, concolorous, slightly glossy to glossy, light green to green; reticulation moderate to dense, with numerous, small, mostly island oil glands, lateral veins at 35° to 45° from midrib. *Inflorescences* axillary, unbranched, 7-flowered, peduncles flattened to angular, 3–5 mm long; buds sessile or pedicels to 1 mm long on centre bud. *Mature buds* obovoid to pyriform, 5–7.5 mm long, 3–5.5 mm wide; hypanthium cupular to obconical, smooth; outer operculum scar present; operculum maturing obtuse to bluntly conical, rounded at tip, equal in width to hypanthium and equal in length to or shorter than hypanthium, smooth. *Stamens* inflexed, all fertile; anthers versatile, oblong, opening by longitudinal slits. *Flowers* white. *Ovules* in four vertical rows. *Fruits* sessile, hemispherical

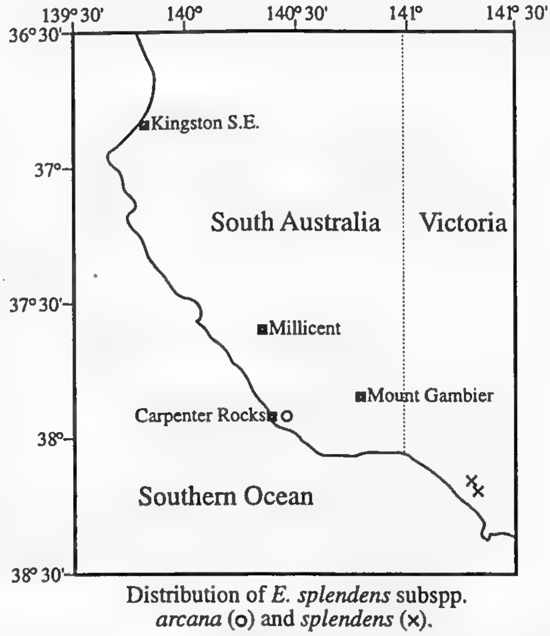
to slightly obconical, 6–7 mm long, 6–8 mm wide, smooth; inner operculum scar inconspicuous, ascending, merging with disc; disc ascending to almost level, to 1 mm wide; valves 3 or 4, broadly triangular, exserted above rim level. *Seed* compressed-ovoid, 1.8–2.5 mm long, dull to slightly glossy, dark brown to almost black, reticulum on dorsal side fine; chaff red-brown.

Selected specimens

SOUTH AUSTRALIA: South-eastern Region: near Carpenter Rocks, 31.i.1986, *I. Brooker 9155* (CANB); Carpenter Rocks vicinity, 30.vii.1996, *I. Brooker 12568 & D. Nicolle* (AD, CANB, NSW, MEL, BRI); Carpenter Rocks vicinity, 30.vii.1996, *I. Brooker 12569 & D. Nicolle* (CANB); Carpenter Rocks vicinity, 30.vii.1996, *I. Brooker 12566 & D. Nicolle* (AD, CANB, NSW, MEL, BRI); East of Carpenter Rocks township, 30.vii.1996, *D. Nicolle 1800 & I. Brooker* (AD, CANB, NSW); North-east of Carpenter Rocks township, 26.ii.1997, *D. Nicolle 1979* (AD, CANB).

Distribution and habitat

E. splendens subsp. *arcana* is endemic to South Australia, known from only a single population spreading over a total distance of less than a kilometre, to the north-east and east of the township of Carpenter Rocks, south of Millicent in the State's far south-east (Fig. 2). The populations all occur within a kilometre of the ocean in dense tall shrubland dominated by *Acacia longifolia* var. *sophorae*. *E. splendens* subsp. *arcana* occurs in locally heavier soils, usually red clay-loam with outcropping limestone boulders on low limestone rises associated as well with *E. obliqua, Acacia myrtifolia, Melaleuca lanceolata* and *Grevillea aquifolium*. Stunted *E. obliqua* occurs more commonly on lighter soils surrounding the *E. splendens* subsp. *arcana* populations. *E. ovata* grows nearby but not within the *E. splendens* subsp. *arcana* population.



Map 1. Distribution of *E. splendens* subspp. *arcana* (o) and *splendens* (×).

Etymology

From the Latin *arcanus* – mysterious and secret, referring to this species being hidden in the dense scrub in an otherwise mostly cleared area.

Flowering period

Poorly known. In February 1997, most plants were in mature bud with some plants beginning to flower.

Fig. 1. ***E. splendens*** subsp. ***arcana*** (D. Nicolle 1978). **A,** mature branch (×0.7); **B & C,** adult leaves (×0.7); **D,** inflorescence (×3); **E,** bud - side view (×3); **F,** bud - longitudinal section (×3); **G,** flower (×3); **H,** style (×7); **I,** stamens (×5.5); **J,** fruits (×1.5); **K–N,** fruit (×2.5); **O,** seeds (×10).

Notes and affinities

The new taxon is clearly a member of the large extracodical *E.* section *Maidenaria* Pryor and Johnson (1971). Within the section, it is superficially similar to *E. viminalis* subsp. *cygnetensis,* but the short, obtuse operculum in the mature bud and the sessile buds and fruits distinguish *E. splendens* subsp. *arcana* populations, on deeper sandier soils to the north.

Juvenile leaf and mature bud morphology suggest a relationship with *E.* ser. *Acaciiformes* Brooker & Slee. *E. splendens* appears to be the taxon linking the *E. aromaphloia* complex (*E.* ser. *Acaciiformes*) which consists of *E. aromaphloia sens. lat., E. fulgens, E. ignorabilis, E. corticosa, E. acaciiformis* and *E. nicholii* with the *E. viminalis* complex (*E.* ser. *Viminales* Blakely) which consists of many species including *E. viminalis* (with subspp. *cygnetensis*, *viminalis* and *pryoriana*). While *E. splendens* has characteristics common to both series and occupies a taxonomic position between the two series, it would be nonsensical to erect a further series to accommodate them. The morphological boundaries between the *E.* ser. *Acaciiformes* and *Viminales* are not clear and further studies may show that they would be more accurately classified as two subseries of *E.* ser. *Viminales.*

E. splendens subsp. *splendens*, a Victorian endemic, is restricted to the Mt. Richmond area between Nelson and Portland in the south-west of the State. *E. splendens* subsp. *arcana* differs from *E. splendens* subsp. *splendens* in its consistently low, scraggy habit; the larger, slightly crenulate juvenile leaves; the larger, sessile buds and fruits and the obtuse operculum. Site differences are also apparent, with *E. splendens* subsp. *splendens* occurring on much deeper, non-calcareous soils further inland from the coast. The two subspecies are geographically separated by about 100 km, however this may be partly an artefact due to large scale land clearing earlier this century.

The new subspecies has been grown in cultivation for many years as "mallee manna gum" (N. Bonney, pers. comm.).

Conservation status

All the known plants of *E. splendens* subsp. *arcana* grow in an area under a Heritage Agreement and the owner is aware of the species occurrence and vulnerability. Most plants are relatively inaccessible and these plants should be at no short term risk. It is unlikely that more populations will be found in the area as most of the area has been cleared for farmland and pine plantations, and a search in what little natural vegetation remains has resulted in the discovery of no new populations. It is remotely possible that it may be found further away in similar coastal areas. The conservation code 2VCit is recommended using the criteria of Briggs and Leigh (1996).

Acknowledgments

We thank Neville Bonney for bringing this rare taxon to our attention and John Jessop for access to the State Herbarium of South Australia. We are most grateful to Gilbert Dashorst for his detailed illustrations of the subspecies.

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NOTES ON *HIBBERTIA* (DILLENIACEAE) 2. THE *H. ASPERA - EMPETRIFOLIA* COMPLEX

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Abstract

The *Hibbertia aspera* group has been re-assessed and the characteristics of the hairs in particular examined in some detail. Eleven species and five subspecies are recognised, illustrated and keyed out on vegetative as well as floral characters. The following new taxa are described: ***H. appressa***, *H. aspera* DC. subsp. ***pilosifolia***, ***H. decumbens***, *H. empetrifolia* (DC.) Hoogland subspp. ***radians*** and ***uncinata***, ***H. hirta***, ***H. hirticalyx***, ***H. notabilis***, ***H. rhynchocalyx*** and ***H. truncata***. The new combination, ***H. cinerea***, is published for *Pleurandra cinerea* R. Br. ex DC. and *H. pallidiflora* Toelken is added to the flora of south-western Victoria.

Introduction

This species complex was selected to demonstrate, in the first of a number of publications planned as a revision of the species of *Hibbertia* in southern and eastern Australia, the problems encountered in the taxonomy of this genus. Although several previous attempts were made to re-assess the classification of this complex, the group shows the neglect typical of the taxonomy of *Hibbertia*, and even more clearly the lack of understanding of species in the genus. It is not clear why the taxonomy of this genus, often with such spectacular flowers, has not engendered the same great interest and popularity that collectors have shown for it. It seems the early history at least in part accounts for this lack of appreciation.

De Candolle (1817) recognised six species in this complex of which one, *Pleurandra ovata*, had been described by Labillardière (1806). Sprengel (1827) formally published Sieber's *Pleurandra astrotricha*. J.D. Hooker (1855) was the first to express concerns about the similarity of species and regarded the complex (as *P. ovata* sens. lat.) as "an extremely variable plant, whose forms I have felt repeatedly inclined to separate.....however find no difference whatever in the flowers and fruit of all these varieties". He thus reduced *P. scabra* to varietal rank of *P. ovata* followed by Mueller (1862) who reduced most of the known species to his *Hibbertia billardierei*, which was to replace *Pleurandra ovata* when transfered to *Hibbertia*. While the latter only remarked that some "forms of *P. ovata* may be distinguished as varieties", Bentham (1863) described five varieties mainly based on leaf shape and tomentum.

A similar trend developed at generic level as Mueller (1862) also reduced the genera *Adrastaea* DC., *Candollea* Labill. and *Pleurandra* Labill. to synonymy of *Hibbertia*, and Bentham continued by amalgamating *Hemistemma* DC., *Ochrolasia* Turcz. and *Hemistrephus* Drummond with *Hibbertia* but retaining *Adrastaea*, *Candollea* and *Pachynema*. Finally Gilg (1893) recognised only the genera *Hibbertia* and *Pachynema* in the Dillenioideae-Hibbertiae in Australia, but some of the names were retained at infrageneric level. This status at genus and species level was maintained for almost one hundred years (Gilg & Werdermann 1925; Stebbins & Hoogland 1976, in discussion) except that Druce (1917) added to the confusion by publishing the illegitimate combination *H. ovata* (Labill.) - non *H. ovata* Steudel (1845). Domin (1928) then transferred all Bentham's varieties to this species.

Very few new taxa were described until Wakefield (1957) resuscitated, as the result of his original research and especially field observations, two species in this complex, namely *H. aspera* with stellate-tomentose undersurface of the leaves, and *H. astrotricha* for those

plants with mainly few hooked simple hairs on the undersurface. He introduced for the first time the importance of different hair types found in this group, but unfortunately he did not follow it through the whole range. Nor does he seem to have been aware of the difference in juvenile plants (cf. juvenile to adult developmental stages) at least in some species of the group. Hoogland (1974) maintained this concept but established that the oldest name of the latter species should be *H. empetrifolia.* He had consulted for the first time in about 150 years the de Candolle types but from his preliminary identifications and manuscripts (CANB but at present on loan in AD) there are no indications that he intended recognising more species in this complex. Even with Wakefield's initiative for original research, publication of species remained restricted to some obviously new taxa for local floras largely described out of context from existing species (e.g. Conn, 1990; Reynolds 1991; Toelken 1996). Even these species were largely delineated on local material.

It is extraordinary that nobody re-assessed the number of stamens, a character mentioned by Labillardière (1806) in the protologue of *P. ovata*, and used by de Candolle (1817) to separate *P. scabra* var. *β* from *P. ovata*, yet J.D. Hooker (1855) could "find no difference whatever in the flowers and fruit" between the various forms which he did not formally recognise. This is but one example where superficially similar plants belong to different species. Without a large number of specimens, it would seem, earlier botanists could not appreciate the range of variation of individual species and were consequently unable to discern distinguishing characters. It is also important to note in the delimitation of taxa that putative hybrids between taxa were found in field observations to be extremely rare, if at all present in some groups of *Hibbertia*, and Stebbins and Hoogland (1976, p. 150) report similar findings.

Fortunately the attractive flowers maintained a constant stream of collections over time so that the present re-evaluation is based on a broad range of material which allowed a better overview of the wide range of local variation usually found in most of the species. As a result the geographic variants can now be individually examined as well as seen as part of the variation of each species. Local variation may seem to link species but that is only part of the whole picture. For instance, the hairs on the leaves of plants of *H. empetrifolia* north of Sydney are often extremely similar to those of *H. decumbens* (cf. *H. empetrifolia* subsp. *uncinata*) but their stamen characteristics still distinguish them. It seems that previous investigators were often misled by convergent evolution of some characters. The large amount of material consulted here allowed such an overview, but also showed that much more discerning collecting is still needed to record and assess as much as possible of the local variation. The author made some field observations but in the *H. aspera* group the work was mainly restricted to South Australia and only some species in Victoria were examined in their natural habitat. One is continually overwhelmed by the variation found which has often not been recorded previously.

It is hoped that immediate publication of completed groups of species will encourage feedback and hopefully provide an incentive for more discerning collecting, observations on the still not appreciated diversity of the floral biology and general basic ecological observations, so that in the short time alotted for the presentation of a flora write-up a similar standard can be achieved to that of treatments of other plants already published in the *Flora of Australia.*

Characters

A wide range of characters is used in this re-evaluation of a group of closely related species, but only a few need further explanation. Many of these will also be applicable to other groups of species but the present discussion refers only to the *H. aspera* group.

Habit

The habit of the species of this group is plastic as in most taxa of *Hibbertia*. The plants usually produce wiry to slightly woody branches, which, when young and actively growing, produce branches of the first and second order with very much elongated internodes and usually larger leaves. Older plants have quite a different habit because of elaborate branching, some of which is di- or trichotomous (as discussed under inflorescence below) and a decrease in the size of the leaves and internodes.

Plants tend to have a decumbent habit but the cane-like branches often scramble into other vegetation. Records of plants up to 2 m or more are known for *H. cinerea*, *H. hirticalyx* and *H. truncata*. The report of 4 m high plants of *H. pallidiflora* (Toelken 1995), is an extreme case. These plants often develop a dense cover on top of others.

Although suckering is common among some *Hibbertia* species, it was only observed in *H. pallidiflora* and *H. truncata*, but the decumbent branches of *H. empetrifolia* were often found rooting at the nodes where they were touching soil. Since plants of these species often occur in groups it is likely that vegetative spread is much more common than has been previously recorded.

Juvenile developmental stages

The morphology of juvenile organs on seedlings often differing drastically from adult growth has been recorded for many plants (e.g. Lubbock 1892). In *Hibbertia* such characters are not only found in seedlings but they are sometimes retained for some time, and often intermediate forms link them to adult stages. Juvenile traits may reappear with new growth, such as, coppicing branches after burning. In the extreme case of *H. pallidiflora,* juvenile growth is in some areas maintained for a long time and/or juvenile characteristics re-appear with the first leaves of every new branch produced.

The stages in the development were found best shown in the changes of the indumentum, especially since in this study particular emphasis was placed on an understanding and subsequent use of the hairs as a tool for identification of different taxa. The full range of variation of particularly the leaves was examined and illustrated, but the general patterns found suggested that available herbarium material is incomplete and, it is hoped, that more discerning collecting will supplement knowledge before a systematic arrangement of the species is attempted . Therefore only the two extremes, the juvenile (not 'seedling' because plants examined were often more advanced but it does include intermediate stages) and adult characters are formally described, and an intermediate range can then be extrapolated from the following general patterns. Whenever intermediate stage/s were available, one was illustrated but these are not necessarily at a similar stage in different taxa. They were included to assist with an understanding of the complete range of character statesfound in a taxon. Reasons for a longer or shorter retention of juvenile/ intermediate characters can at present not be assessed and seem to be different for every species, and sometimes even between local forms within species.

With limited herbarium material and field studies available for the present study it was assumed here that the stages of, for instance, the hooked simple hairs to stellate hairs on the undersurface of the leaves followed similar patterns in all the species with such adult leaves, although some of these juvenile stages have not been recorded for all these species. Question marks were inserted in the illustrations to show where stages are presumed unknown, as opposed to those species where apparently these developments do not take place either because the species concerned is presumably primitive, e.g. *H. decumbens*, or, in the case of *H. empetrifolia*, seem to have retained some of their juvenile characters (cf. affinities below). The following stages are usually observed:

1. The indumentum of branches with leaves showing juvenile characters tends to be similar to that of adult branches except that it is usually more sparse and often the individual stellate hairs have fewer branches.

2. Juvenile leaves tend to be more obovate and smaller than adult leaves from fast growing branches (with long internodes), but they are generally comparable to those from older branches.

3. The indumentum of the adaxial leaf surface shows usually a range from simple hairs more or less antrosely inclined in juvenile leaves to –

   usually some stellate hairs with few antrorse branches (often unequally long) usually mixed with simple hairs in the intermediate stages to –

   usually more or less dense stellate hairs with about equal branches radially arranged in the adult stage. Simple hairs are commonly found in, or restricted to a strip along the flanks and the depression above the central vein.

4. The indumentum of the abaxial leaf surface (excluding the flanks and central vein) varies from usually only hooked simple hairs (in some local forms these hooked hairs are absent or almost so, in others the occasional scattered stellate hairs are found interspersed) to –

   increasing numbers of stellate hairs with short similar branches in between hooked simple hairs in the intermediate stages to –

   usually stellate-velutinous to -woolly with long equal branches of the stellate hairs often somewhat depressed and strongly overlapping in the adult stage. A few larger stellate hairs with pronounced tubercles are found in some species, but they are usually of the same soft texture.

5. If flowers are present on material with juvenile or intermediate characters then they are usually leaf-opposed and rarely with subwhorled leaves below the peduncle (cf. inflorescence, affinities below), except in *H. pallidiflora*, where the different stages are often not clearly separated.

In the latter species juvenile and intermediate characters occur, are maintained or recur for as yet unknown reasons (cf. Toelken 1995). Similarly, juvenile characters have often been observed on specimens of *H. hirticalyx* from Tasmania, but not one specimen from Victoria showed leaf characters other than adult. While in *H. pallidiflora* at least some of the variation seem to be ecologically induced, there are indications that those of the two forms of *H. hirticalyx* are genetically fixed, but in both cases generalisations should be avoided.

Considering the known variation of the shape and size of leaves as well as the indumentum, it is obvious that Bentham's concepts could not provide natural delimitations of the taxa. This study of the range of variation of the indumentum in each species is not only important for the delimitation and subsequent identification of these species, but also gives, when provided with a predictable range of characteristics, some indications on the affinities of the various taxa to one another (cf affinities below). These are, however, only generalisations as a basis for further discussion in a group plants that has been neglected for a long time.

Indumentum (Vestiture)

The hairs covering various organs of the plants are at times so varied in the species of sect. *Pleurandra* that a special descriptive system has been developed to maximise the use of these characters yet allow for observed variation. The hairs are here described under the broad entry of **vestiture** for the types and shapes of hairs, their variation, distribution and

stratification. A separate indication of the denseness and texture, e.g. pilose, is provided only for young individual organs in order not to be misleading because it refers only to the visible simple hairs overtopping at first, but as they usually wear off they expose the velutinous cover of short stellate hairs on older leaves and branches of, for instance, *H. rhynchocalyx*. 'Vestiture' is used here to describe the detail in contrast to 'indumentum', which as used by Hewson (1988) also includes indications of texture and denseness, so that the two terms as used here are not interchangeable. This division of characters allowed a greater versatility to describe the large variation found in some species of *Hibbertia* without duplicating information for each organ. In a few cases some hair characters needed accentuating in connection with certain organs at the risk of an apparent inconsistancy in the overall treatment. The absence of such information in other taxa should be interpreted as negative.

Each character of the vestiture is, like any other taxonomic character, only described when its range of variation (usually including its juvenile range) on a specific organ of a certain taxon has been evaluated. As a rule the vestiture of a few key organs, viz. branches, upper and lower leaf surfaces and the calyx lobes were examined and described, but there are also references to specific features of other organs. More information and especially field observations is still needed as many of these genotypic and phenotypic variations, e.g. differences of vestiture between juvenile and adult leaves as in *H. pallidiflora,* showed that these are probably affected by environmental factors causing, for instance, a prolonged retention of these juvenile characters, which in turn could result in misidentification of material.

HAIR TYPES

The basic distinction between simple and stellate hairs is sometimes not obvious, because when simple hairs form from adjoining epidermis cells the swollen basal tubercles often join so that the structure should be called a stellate hair. Similarly the branches of stellate hairs often do not seem to develop, or wear off easily and the apparent contradiction to stellate hairs with 1–3 branches is determined by comparison with the size, shape and deflection of the surrounding hairs.

The **tubercle** is an arbitrary term often used in descriptions of hibbertias for a more or less swollen base of simple and stellate hairs. In addition to the tubercle, simple and stellate hairs on the upper leaf surface of species of the *H. aspera* group are usually surrounded by **base cells**, which are somewhat bulging epidermis cells with thickened walls. These hairs are somewhat reminiscent of those found in the Boraginaceae, but in the *H. aspera* group are never coarse. The base cells together with remains of the tubercles are the paler spots usually observed on older leaves where the hairs have largely worn off. Hooked simple hairs which are occasionally found on the upper surface of leaves of some forms are usually without base cells.

The **simple hairs** are apparently always unicellular from an epidermal cell and often with a basal swelling or tubercle. They are straight or with a hooked apex, and often longer than stellate hairs, so that the frequently used terms 'pilose' or 'hirsute' refer to the visible single hairs. While straight simple hairs are more or less antrorsely inclined, rarely curved, hooked simple hairs are usually erect or rarely retrorsely inclined particularly on the calyx.

Stellate hairs in *Hibbertia* are formed by a clustering of simple unicellular hairs (fig.1A), the bases of which are more or less connate to form a longer or shorter tubercle. They are very variable and the alternatives are retained in the following sequence in all descriptions in order to remain consistently comparative in the wide range of combinations of characters as required (fig.1B):

persisting/ wearing off except basal tubercles, erect/ multiangulate/ depressed, radial/ antrorse/ retrorse stellate hairs (with number of branches) with small/ broad/ stalked tubercle base.

A simple terminology was maintained in order to keep it self-explanatory. "Erect" and "depressed" do not replace Hewson's (1988) "porrect" (though the odd hair on plants of the *H. aspera* group may produce a straight erect central hair) and "rotate" or "peltate" (branches of hairs in this group are rarely in one plain) respectively, and some of Hewson's terms may be used in subsequent papers in this series. Basically they are multiangulate stellate hairs and "erect" refers to hairs usually with only a few branches all of them at 75 or more from the base; "depressed" to hairs with all branches less than 35 to 40 from the base. The term "stalked stellate hairs" (Toelken, 1996) was used to avoid confusing them with dendritic hairs, because their branches spread from more or less the same point and the length of the tubercle is relative to that of other stellate hairs on that specific organ. Considerable variation of stellate hairs occurs between specimens of the same species and between leaves of juvenile or adult plants.

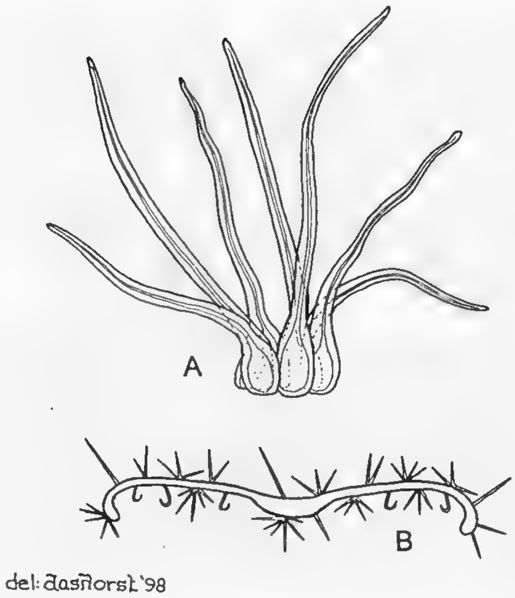

Fig. 1. Hairs. **A**, ***H. cinerea***: stellate hairs are composed of several adjoining simple hairs ×50; **B**, diagram of juvenile leaf of ***H. aspera*** subsp. ***aspera*** showing above few simple hairs above multiangulate antrorse stellate hairs (few often unequal branches), and below few multiangulate radial stellate hairs (many, often similar branches) rarely overlapping with hooked simple hairs ×20. (**A**, *R. Alcock 625*, AD; **B**, *C.T. White BRI 10502*).

Stellate hairs usually have similar branches, but occasionally there are distinctly unequally long ones found especially when there are larger stellate hairs over smaller ones as in *H. cinerea*. These unequal branches can reach extremes in cases where one or two branches may extend to more than twice as long as the other branches, and may on superficial investigation be confused with single hairs over stellate ones.

Although some sequences of the above terms might seem to indicate progression to more complex conditions, and this might be observed in particular examples, generalisations should be avoided as there is, for instance, evidence for increasing as well as decreasing number of branches of stellate hairs within the species of this group.

In the above descriptions the following words are added in order to provide a simple image of the three dimensional stratification of the hair cover similar to that of vegetation (cf. fig. 1B) *over/ similar/ under* together with *overlapping* (free being usual) accepting that the distribution of the different types is a random scatter unless specific accumulations are mentioned. This simplification expressed useful descriptive information of the hair cover which could otherwise only be obtained by unjustifiably cumbersome measurements.

Leaves

The shape and size of the leaves often varies considerably from young to older branches but can equally vary on the same plant predominantly due to the amount the margins are recurved, which depends on the environment or techniques of drying specimens. These are therefore generally not useful characters in this group of species.

The description and illustration of juvenile and adult leaves and especially their indumentum represents extremes observed (cf. juvenile to adult developmental stages). The extent of the variation found seems to vary with environment, as particularly shading seem to have a retarding influence on the development of adult leaves, but the duration of expression of the juvenile leaves is also variable in different taxa (cf. subpecies of *H. aspera*), and may be repeated in some species, e.g. *H. pallidiflora*, with every new axis developing.

Discolourous leaves are not entirely due to their indumentum, as leaves of *H. empetrifolia*, which often has glabrescent older leaves (above and below), are usually paler below.

Inflorescence and flowers

The concept of an inflorescence has not been developed in *Hibbertia* although accumulations of flowers have been recorded in some groups of species in the genus. Flowers in *Hibbertia* are commonly single, terminal and often become leaf-opposed by sympodial growth (e.g. *H. decumbens,* fig.6A). Flowers maydevelop repeatedly at intervals of three or four internodes (e.g. *H. hirta*).

Two or three leaves below the peduncle of most of the species of this group are not separated by internodes so that they are here referred to as subwhorled. Sympodial growth from their axils often results in di- or trichotomous branching, and only in the latter case can one observe the terminal position (leaf-opposed) of the flower. If, however, one of the three axillary buds has not developed into a branch then the flower will appear to be axillary to that subwhorled leaf.

Some forms particularly of *H. aspera* and *H. empetrifolia* produce flowers on short shoots without fully developed leaves, sometimes in the axils of leaves along the main branches. These and normal flowering branches then produce one to three fascicled axillary branches (sympodial growth) with vestigial leaves (cf. fig. 4A), which often drop off early, so that the cluster of flowers thus formed appears to be a few-flowered inflorescence especially as the peduncle of each flower often remains intact for more than a year. They are, however not referred to as inflorescences because, unlike a raceme or cyme, or even the complex inflorescences described for some of the species of *Dillenia* (Corner 1978), there are several nodes of vegetative growth, however short, between subsequent flowers. The same applies to the dense clusters of flowers with special bract-like leaves in the *H. sericea* complex (Toelken, in preparation). Troll's definition of an inflorescence as "the shoot system which serves for the formation of flowers and which is modified accordingly" (Weberling 1987) could cover some forms of this species complex, but the concept of a single terminal flower is here preferred so that one can show the different developments within the genus more clearly.

Since the single terminal flower was accepted as the basic unit, the characteristic elongated internode between the subfloral bract and first leaf is here called "peduncle"; the internode between the bract and the flower is then referred to as "anthopodium" (Briggs & Johnson 1979), in preference to "pedicel", which has been used for so many different conditions in literature (Conn, 1995).

The characteristic subulate bracts always subtend the calyx in the *H. aspera* group. They are without recurved margins and their length relative to the calyx was found a useful

character to distinguish some of the species while in others, e.g. *H. empetrifolia*, it is variable.

The buds of most species are broadly ellipsoid but in the case of *H. empetrifolia* they are narrowly ellipsoid and the base of an open flower is not abruptly constricted but more or less stepped. This is due to a reduction of the number of ovules from four laterally attached to the placenta along the suture of the carpel to two, more or less basal ovules in the latter. In the process the position of the ovules changes from parietal (horizontal), or almost so in the case of four ovules, to basal (erect) when two ovules are produced.

Calyx and corolla

In contrast to the petals the calyx lobes are usually basally connate. In the *H. aspera* group the outer three are commonly different from the inner two in shape, indumentum and the presence of a more or less pronounced central ridge, while in many other groups it is the outer two and inner three calyx lobes that are similar.

The petals vary greatly in size, the shape of the claws, and their apices can vary from truncate, emarginate to deeply lobed, sometimes even within a population of a species. The shape of the base of the petals can, in the *H. aspera* group, be distinctive as it is cuneate (cf. fig. 7A) in the species with fewer than eight stamens and tends to be more rounded to obovate in species with ten or more stamens. It remains a character of limited use on herbarium material.

Stamens

The species of the *H. aspera* group can be divided into those with (9) 10–12 (-15) stamens and 4–8 (9) in *H. aspera* and *H. empetrifolia*. The anthers of the group with more stamens are oblong (fig. 2D) and (1-) 1.2–1.5 (-1.8) mm long while those of the latter are usually oblong-oblanceolate (fig. 2E) and (0.6-) 0.7–0.9 (-1.1) mm long in herbarium specimens. The length of the anthers in the group with many stamens does not vary as much as in the others where one or more of the central ones are usually enlarged as part of the pollination syndrome. In some species the anthers, again especially the central ones, have short pointed appendages from the connective (fig. 2D).

The filaments are usually connate for more than half their length in *H. hirticalyx*. Even in this species there is some variation but in others there is even more. As in most *Hibbertia* species with stamens in one bundle (sect. *Pleurandra*) their filaments are variously basally connate but in local forms the amount of fusion of all or bundles of them varies, and is constant in only a few species. In the *H. aspera* group it was not found to be a reliable character.

The solid filaments and the closely packed anthers are more or less curved forward (fig. 2A,B) to cover the styles so that just the stigmas protrude horizontally. This suggests a specialised pollination syndrome unique to species of the *H. aspera* group except for *H. pallidiflora* which has tubular petals (Toelken 1995). Flowers in this group are therefore more zygomorphic than in other species of sect. *Pleurandra.*

Fruit

The shape of the fruit also varies according to whether two or four seeds develop. As the ovary enlarges the original villous indumentum becomes sparser so that one can distinguish the normally stellate hairs but in *H. appressa* they are simple.

There are usually two to four ovules (rarely up to six in *H. truncata*) in each carpel and the fewer there are the more basal the placentation usually becomes. Rarely more than two

seeds per carpel mature and the position of the attachment is also often displaced at maturity, so that little importance was attached to these characters.

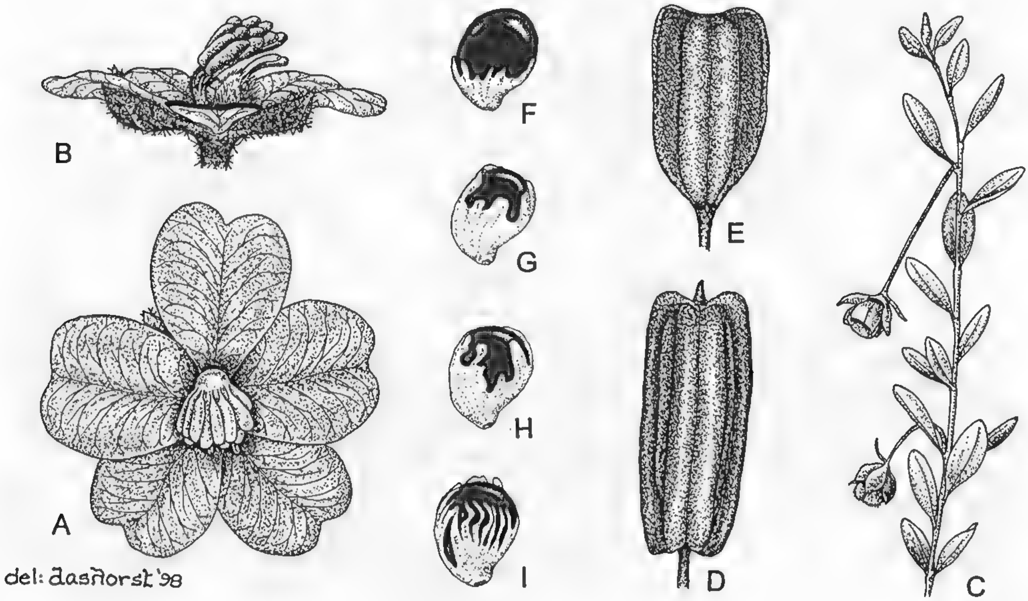

Fig. 2. Flowers and fruit. **A**, **B**, ***H. truncata***: **A**, front view of rotate flower with stamens curved forward as commonly found in the *H. aspera* group ×3; **B**, side view of androecium curved over the gynoecium to place apex of anthers above stigmas ×3. **C**. ***H. pallidiflora***: flowering and fruiting branch showing unique pendulous flowers with tubular petals (free petals arranged in a cylinder) shorter than calyx (one lobe removed) ×1.5. **D**, ***H. rhynchocalyx***: oblong anther with appendage terminal to connective ×30. **E**, ***H. empetrifolia*** subsp. ***radians***: oblanceolate anther with flared apex ×30. **F–I**, ***H. aspera*** subsp. ***aspera***: the aril on seeds of the same plant varies in size and may develop broad lobes to finger-like processes ×6. (**A**, **B**, *H.R. Toelken 9251*, AD; **C**, *H.R. Toelken 8567*, AD; **D**, *J.B. Williams 603*, NSW; **E**, *H.R. Toelken 8681*, AD; **F–I**, *Price NSW 10293*).

The seeds vary considerably in size and shape depending on the number developing in the same carpel as well as on environmental conditions as in many cases sudden heat waves etc. seem to produce premature ripening of the seeds. While most seeds are shiny black they become brown to light brown under those conditions.

The aril in this group of species develops from an upper fleshy collar of the funicle a membranous sheath of varying size and lobing (fig. 2F–I) even within the species. When four ovules develop the sheath usually does not develop well in the contact zone. The aril also seems to be smaller in prematurely ripened seeds, so that this variable character cannot be used to distinguish species within the *H. aspera* group but the well developed membranous sheath will distinguish members of this group from others in the genus.

Affinities

The species have for convenience been alphabetically arranged but the limited information available allows some speculation on the affinities of the different taxa recognised here.

The most effective characters to show progressively more complex developments are associated with the arrangement of the flowers. In *Hibbertia* the basic type is the single terminal flower, which becomes leaf-opposed by sympodial growth of the axillary bud from the subtending leaf. Mainly leaf-opposed flowers are only found in *H. decumbens*. They are also more or less frequently found, in addition to other types of flower arrangements, in many other species of the *H. aspera* group, but they are then usually associated with juvenile leaves. *H. decumbens* is unique in that it was seen to produce, in contrast to all the other species, only one flower per branch per season, and they usually remained except for a few flowers leaf-opposed in sucessive years. Since the limited material available did not show any sign of different stages in the leaf development, the combination of the leaf and flower characters could not be used to establish whether the rare occurrence of subwhorled leaves below flowers are a normal development in this species or are restricted to local forms.

Usually, however, the terminal flower in this group of species is subtended by two or three (up to five) subwhorled leaves, i.e. the internodes between these leaves are very much reduced. Continued axillary growth will appear di- or trichotomous etc., as usually more than one axillary bud resumes growth, but if not each axillary bud of the clustered leaves continues growth, the flower will appear to be axillary. The true terminal position of the flower can only be observed when vegetative growth is continued from the axil of each of the subtending leaves. Each of these developing branches has at times been observed to produce more flowers, but usually with a minimum of three or four vegetative nodes commonly with normal leaves in-between. This can be repeated several times in one season.

The second type of specialisation is that some or all flowering branches are further reduced to short shoots. Extreme forms with reduced to vestigial leaves are mainly observed in *H. aspera* and *H. empetrifolia*, and occasionally also in *H. appressa*, which is very similar to the latter.

The shape of the individual cells of the stellate hairs (fig.1A) suggest that they have developed from groups of adjoining simple hairs, and often some such clusters were observed among simple hairs, which sometimes obscure the difference between these two basic types of hairs (cf. indumentum). Hooked simple hairs are, however, different as they are usually found quite separate and very rare occurrences of stellate hairs with hooked branches in some forms of *H. empetrifolia* have not been observed to relate to similar clustering of hooked simple hairs. Stellate hairs formed on the undersurface of juvenile leaves between hooked simple hairs have not been observed to develop hooked branches. It is then significant that the earliest leaves of all species examined (juvenile leaves of three species have not been seen) have only hooked simple hairs, although sometimes only a few of them on their undersurface.

If *H. decumbens* is the most primitive species according to its flower arrangement, then it is interesting to note that it is also the species with the fewest stellate hairs except for a few local variants of *H. appressa* and *H. empetrifolia*, and produces like those two species hooked hairs on the undersurface of all its leaves. It is also interesting, although no conclusions could at present be drawn from the fragmentary information available, that, similar to *H. decumbens*, juvenile plants produce leaves which tend to produce less branched stellate hairs and apparently only hooked hairs on the undersurface as well as leaf-opposed flowers. In contrast to *H. decumbens*, *H. appressa* and *H. empetrifolia* have a more complex flower arrangement.

H. decumbens has 9–12 (-15) stamens suggesting that larger numbers of stamens are also a primitive character in the *H. aspera* group as Stebbins and Hoogland (1976) had suggested for the genus. The anthers of *H. decumbens* are narrowly obloid as in all other species with more than 10 stamens. The few stamens found in flowers of *H. aspera* and *H. empetrifolia*, and especially that the anthers are usually shorter and somewhat broadened at the apex particularly in the latter species indicate advanced standing. Both *H. empetrifolia*

and the very similar *H. appressa* have very few stellate hairs and hooked hairs on the undersurface of leaves, yet show apparently advanced characters in their flower arrangement as well as in the number of stamens at least in the former. Since neither in the large numbers of specimens examined of both these species nor in any populations observed in the field were any juvenile leaves found, this strongly suggests that the simple hairs and especially the commonly found hooked simple hairs on the undersurface of the leaves are a retention of a juvenile character if compared with *H. aspera*, the third very similar species in this complex. The apparently primitive *H. appressa* and *H. empetrifolia* are possibly because of this reduction more advanced than *H. aspera*.

H. appressa, *H. aspera* and *H. empetrifolia* are different from all the other species in that except for some of their subspecies they are widespread and occur in a wide range of habitats. The only character that they have in common is their more or less cuneate petals suggesting that the shape together with the reduced number of stamens may be part of a particular pollination syndrome. The different indumentum, however, suggests that *H. notabilis – H. aspera* and *H. appressa – H. empetrifolia* are convergent pairs of species.

Both *H. decumbens* and *H. hirta* are found in restricted areas on the Tablelands of central and south-central New South Wales respectively. *H. rhynchocalyx* is known only from one collection in the Gibraltar Range of northern New South Wales. *H. hirticalyx* (Wilsons Promontory, Victoria and northern Tasmania), *H. truncata* (vicinity of Port Campbell, Victoria), *H. cinerea* (vicinity of Port Lincoln, S. Australia) and *H. pallidiflora* (Kangaroo Island and adjoining mainland but extending just into Victoria) have a restricted distribution, although often locally common. All these species except *H. decumbens* share many characters and give the impression of relics of a once widespread and very variable complex. Each one has possibly further evolved in their isolation, as is, for instance, shown in the unique tubular flowers of *H. pallidiflora*. *H. decumbens*, the most primitive species according to this, shows no close affinities to any other species.

The following linear arrangement of the species based on the above arguments as well as supported by other similarities in their morphology is suggested: *H. decumbens*, *H. hirta*, *H. rhynchocalyx*, *H. hirticalyx*, *H. truncata*, *H. cinerea*, *H. pallidiflora*, *H. notabilis*, *H. aspera*, *H. appressa*, *H. empetrifolia*.

H. aspera group

This group of species was selected because members are easily distinguished from other species in the sect. *Pleurandra* by, in particular, the flat leaves with scarcely recurved to moderately revolute margins so that the undersurface is normally visible; the elongated peduncle which becomes recurved when fruiting; and the closely packed anthers which are more or less horizontally fanned forward to cover the styles with only the receptive stigmas protruding beyond their apices, except in the tubular flowers of *H. pallidiflora*, where the styles are longer.

Here the species are alphabetically arranged and not numbered so as to avoid a numbering system that cannot be maintained in the treatment of the whole genus.

The detailed localities and descriptions published by de Candolle (1817), which even include reference to the habit of the plants, must have been drawn up from the often small duplicates sent to him. The protologue based on R. Brown specimens does not agree with the collector's manuscript descriptions except for the name and locality. Authorship is maintained as 'R. Br. ex DC.' and the specimens in G-DC are regarded as holotypes. Many lectotypes were selected even for illegitimate names to clarify concepts.

Key to the species and subspecies based largely on floral characters

It was found best to describe the vestiture of the leaves in terms of 'above' and 'below' (not adaxial and abaxial surfaces), because the revolute portions of the adaxial surface are often such an important part of the leaves "below". For similar reasons the lateral sides of the leaves are called 'flanks' and the 'undersurface of leaves' here excludes the revolute margins and central vein so that it is not strictly synonymous with the abaxial leaf surface. References to the central vein always apply to the abaxial leaf surface because here it is clearly visible.

1. Corolla tubular (the free petals are arranged in a cylinder), shorter than calyx; styles clearly overtopping apex of anthers .... *H. pallidiflora*

1: Corolla rotate, longer than calyx; styles exposing stigmas about level with apex of anthers 2

2. Stamens (2-) 4–6 (-9); dried anthers obloid to obloid-obovoid, tapering towards the base, 0.5–1 (-1.2) mm long 3

3. Undersurface of leaves ± densely covered with stellate hairs; buds and flowers abruptly constricted into peduncle 4

4. Stellate hairs on upper leaf surface multiangulate, radial and with 5–15 branches, or occasionally mixed with antrorse hairs with 2–5 branches .... *H. aspera* subsp. *aspera*

4: Stellate hairs on upper leaf surface erect, radial and with 1–3 branches, if antrorse then 1–3 branches 5

5. Upper leaf surface with erect, radial to antrorse stellate hairs with 1–3 (4) branches; stellate hairs on the undersurface with 2–5 branches, scarcely overlapping .. *H. aspera* subsp. *pilosifolia*

5: Upper leaf surface mainly with spreading simple hairs or smaller antrorse ones sometimes with 2 branches; stellate hairs on undersurface with >7 branches, strongly overlapping .... *H. aspera* × *H. empetrifolia*

3: Undersurface of leaves without stellate hairs except along the flanks and the central vein; buds and base of flower constricted or stepped (cf. fig. 7F) into peduncle 6

6. Plants usually prostrate; some stellate hairs on the flanks of mainly the upper leaf surface radial, broad-tubercled and with 8–15 branches .... *H. empetrifolia* subsp. *radians*

6: Plants spreading or decumbent; stellate hairs on upper leaf surface antrorse or rarely radial, with small tubercle and 1–4 branches 7

7. Stellate hairs on branches and peduncle with (4) 5–14 branches; hooked simple hairs absent on upper leaf surfaces, or if present then not combined as below .... *H. empetrifolia* subsp. *empetrifolia*

7: Stellate hairs on branches and peduncle with 1–3(4) branches; hooked simple hairs present on upper leaf surfaces .... *H. empetrifolia* subsp. *uncinata*

2: Stamens (9) 10–12 (-15); dried anthers usually narrowly obloid, with truncate base, (1-) 1.2–1.8 (-2) mm: 8

8. Bract subtending flower up to half as long as calyx 9

9. Undersurface of leaves densely covered with stellate hairs 10

10. Upper leaf surface with simple and antrorse stellate hairs; southern NSW, eastern Victoria .... *H. notabilis*

10: Upper leaf surface with radial stellate hairs; south-western Victoria .... *H. truncata*

9: Undersurface of leaves except flanks and central vein covered with simple hooked hairs 11

11. Outer surface of outer calyx lobes with long appressed simple hairs over/without small stellate hairs .... *H. appressa*

11: Outer surface of outer calyx lobes with larger stellate hairs with unequal branches over small ones with similar branches and/or hooked hairs .... *H. decumbens*

8: Bract subtending flower two-thirds to as long as calyx 12

12. Outer surface of outer calyx lobes with erect to multiangulate larger stellate hairs over smaller ones .... *H. cinerea*

12: Outer surface of outer calyx lobes with simple over stellate hairs 13

13. Upper leaf surface and outer calyx lobes covered with simple rarely stellate hairs .... *H. hirta*

13: Upper leaf surface and outer calyx lobes with simple over stellate hairs 14

14. Anthers with a terminal appendage; simple hairs on branches, leaves and calyx 1–2 mm long .... *H. rhynchocalyx*

14. Anthers truncate or emarginate; simple hairs on branches, leaves and calyx up to 1 mm long .... *H. hirticalyx*

Key to the species and subspecies based largely on hair types

Examine the undersurface of at least one leaf at the apex and the base of each specimen:

A. If both have similar hairs then use couplet 1.

B. If the upper leaf has a different indumentum, use only the upper adult leaves, i.e. when only stellate hairs are present on the undersurface, continue with couplet 5; if hooked simple and stellate hairs, then follow C.

C. If all leaves of specimen have a mixture of hooked simple hairs and stellate hairs on their undersurface, then attempt identification by the geographic distribution of species combined with matching the indumentum of intermediate leaves with illustrations for all species (see also developmental trends: juvenile to adult developmental stages). But first check carefully as sometimes adult leaves with only stellate hairs below are found at the apex of other branches on the same specimen.

1. Undersurface of leaves except flanks and central vein ±covered with simple hooked hairs or glabrescent 2

2. Simple hairs on upper leaf surface and calyx appressed .... *H. appressa*

2: Simple hairs on upper leaf surface and calyx spreading to erect 3

3. Upper leaf surface without stellate hairs: 4

4. Branches with larger stellate hairs with unequal branches over smaller ones .... *H. decumbens*

4: Branches with similar stellate hairs with similar branches .... *H. empetrifolia* subsp. *uncinata*

3: Upper leaf surface with stellate hairs 5

5. Leaf flanks, central vein and petiole below with radial stellate hairs with 6–14 branches .... *H. empetrifolia* susbp. *radians*

5: Leaves with usually antrorse stellate hairs with 1–3 (4) branches 6

6. Upper leaf surface without hooked hairs, or if hooked hairs present then larger and smaller stellate hairs with (4) 5–12 branches on branches .... *H. empetrifolia* subsp. *empetrifolia*

6: Upper leaf surface with hooked hairs; branches with uniform stellate hairs with 1–3 (4) branches .... *H. empetrifolia* subsp. *uncinata*

1. Undersurface of leaves ±densely covered with stellate hairs (rarely mixed stellate and hooked simple hairs on juvenile leaves) 7

7. Branches without simple hairs, with larger multiangulate/erect radial stellate hairs over smaller ones 8

8. Adult leaves usually discolourous with distinctly fewer hairs above .... *H. truncata*

8. Adult leaves with stellate hairs on both surfaces ±equally dense 9

9. Shrubs to 2 m tall, with erect or spreading rigid branches; flanks of upper leaf surface with scattered larger erect stellate hairs each with 1–5 (-8) often unequal branches .... *H. cinerea*

9: Shrubs with decumbent wiry branches, usually scrambling and then up to 4 m high; flanks of upper leaf surface with scattered larger multiangulate stellate hairs each with >18 similar branches .... *H. pallidiflora*

7: Branches with simple hairs, or if without then stellate hairs about equal 10

10. Upper leaf surface with mainly simple hairs except for occasional antrorse stellate ones 11

11. Undersurface of leaves stellate-pubescent overtopped by long simple hairs from the flanks and the central vein; upper leaf surface pilose with long simple hairs .... *H. hirta*

11: Undersurface of leaves stellate-velutinous with few short simple hairs on flanks and central vein; upper leaf surface pubescent with short simple hairs and some antrorse stellate hairs ..... *H. notabilis*

10: Upper leaf surface with few antrose simple hairs over many more radial stellate hairs or sometimes mixed with few antrorse stellate hairs 12

12. Simple hairs up to 2.5 times longer than stellate ones; stamens (2-) 4–7 (-9) 13

13. Stellate hairs on upper leaf surface multiangulate, radial and with 5–15 branches, or occasionally mixed with antrorse hairs with 2–5 branches .... *H. aspera* subsp. *aspera*

13: Stellate hairs on upper leaf surface erect, radial and with 1–3 (4) branches, if antrorse then 1–3 branches 14

14. Upper leaf surface with erect, radial to antrorse stellate hairs with 1–3 (4) branches, stellate hairs on the undersurface with 2–5 branches and scarcely overlapping .... *H. aspera* subsp. *pilosifolia*

14: Upper leaf surface mainly with spreading simple hairs or smaller antrorse stellate hairs with 1 or 2 branches; stellate hairs on the undersurface with >7 branches, strongly overlapping .... *H. aspera* × *H. empetrifolia*

12: Simple hairs >3 times longer than stellate ones; stamens (9) 10–12 (-15) 15

15. Undersurface of leaves stellate-velutinous with some simple hairs on flanks and central vein; southern Victoria, Tasmania .... *H. hirticalyx*

15: Undersurface of leaves stellate-pubescent overtopped by long simple hairs from flanks and central vein; northern New South Wales .... *H. rhynchocalyx*

H. appressa Toelken, *sp. nov.*

Pleurandra ovata Labill., Nov. Holl. Pl. Specim. 2: 5, t. 143 (1806); Poir. in Lamarck, Encycl. Méth. Bot. 8: 444 (1808); DC., Regn. Veg. Syst. Nat. 1: 418 (1817); Prodr. 1: 72 (1824); Spreng., Syst. Veg., edn 16, 2: 463 (1825); Hook., J. Bot. (Hook.) 1: 246 (1834); Hook., Companion Bot. Mag. 1: 273 (1835); Hook.f., J. Bot. (Hook.) 2: 401 (1840); A. DC., Linnaea 25: 577 (1853); Hook.f., Fl. Tasm. 1: 16 (1855).

Type: Tasmania, *J.J.H. Labillardiere s.n.*(lecto. – selected here: right specimen on sheet Herb. Webb. No. 3936: FI; photo., AD; syn.: G-DC; for excluded specimens see *P. scabra* var. *β* under *H. empetrifolia* subsp. *empetrifolia*).

P. ovata Labill. var. *prostrata* Hook.f., Fl. Tasm. 1: 16 (1855), *nom. inval.*

Type: Tasmania, *R.C. Gunn 183/1836* (lecto. selected here: K).

Hibbertia billardierei F. Muell., Pl. Indig. Col. Vict.. 1: 14 (1862), partly, "*Billardierii*"; Benth., Fl Austr. 1: 28 (1863), partly, "*Billardieri*"; F. Muell., Native Pl. Vict. 1: 16 (1879), partly, *nom. illeg., nom. superfl.*, "*Billardierii*".

Type: Victoria, near Snowy River, iii.1854, *F. Mueller MEL 31515* (lecto. – selected here: MEL; syntypes excl., cf. typification).

H. billardierei F. Muell. var. *ovata* Benth., Fl. Austr. 1: 28 (1863).

Type: Tasmania, *R.W. Lawrence 203* (lecto. – selected here: K).

H. billardierei F. Muell. var. *obovata* auct. non R. Br. ex Benth.: Benth., Fl. Austr. 1: 28 (1863), as for "Hastings river, Beckler".

H. ovata (Labill.)Druce, Rep. Botl Soc. Exch. Club Br. Isl. 1916: 628 (1917), *nom. illeg.*; Domin, Biblioth. Bot. 89: 422 (1928), *nom. illeg.*; Ewart, Fl. Vict. 769 (1931), *nom. illeg., non* Steud. (1845).

Type: as for *P. ovata.*

H. ovata (Labill.) Druce var. *typica* Domin, Biblioth. Bot. 89: 422 (1928), *nom. inval.*

Type: as for *P. ovata.*

H. astrotricha auctt. non (Sieber ex Spreng.) N.A. Wakef.: N.A. Wakef., Vict. Nat. 73: 167 (1957), partly, "*asterotricha*"; J.H. Willis, Pl. Vict. 2: 391 (1973), partly, as for *P. ovata.*

H. empetrifolia auctt. non (DC.) Hoogland: Hoogland, Kew Bull. 29: 155 (1974), partly; W.M. Curtis & D.I. Morris, Stud. Fl. Tas. edn 2, 1: 23 (1975), partly; M. Gray et al., Fl. Melbourne 122, fig. (1993); Toelken in N.G. Walsh & Entwisle, Fl. Vict. 3: 313 (1996), partly, as for *P. ovata.*

Shrublets decumbent, 0.3–0.6 m high but with scrambling branches up to 2 m high, often sparsely branched, puberulous or glabrescent. *Vestiture* on branches and calyx persistent, with mainly long inflexed (antrorse) more or less appressed simple hairs over usually few very small multiangulate radial stellate hairs (3–6 similar or unequal branches) both with small tubercle and apparently no base cells; *leaves above* persistent or sometimes wearing off, with similar long appressed simple hairs each with distinct tubercle of one row of raised base cells; on *leaves below* with similar persistent simple hairs as above on flanks and central vein and with glabrous undersurface or rarely with few to many hooked simple hairs but soon wearing off; *juvenile* leaves apparently not different. *Leaves* sometimes with axillary tuft of hairs because of latent axillary buds; petiole (0-) 0.4–1 mm long; lamina lanceolate-elliptic, broadly ovate-elliptic or obovate-elliptic to elliptic or rarely oblong because of strongly revolute margins, (2.2-) 3.5–9 (-12.2) × (0.9-) 2.8–4.8 (-6.3) mm, acute to mucronate with excurrent central vein, gradually constricted into petiole, flanks often slightly undulate (due to raised base cells of hairs), more or less revolute exposing some of the undersurface between them and the slightly raised central vein; surfaces puberulous to glabrescent with robust appressed hairs mainly along the flanks and the raised central vein below, sometimes with few to many short hooked simple hairs, soon becoming glabrous. *Flowers* usually abruptly constricted into the peduncle or sometimes more or less stepped in southern Tasmania (buds almost spherical before opening), terminal often only on lateral branches, rarely on short shoots, subtended by 2 or 3 subwhorled leaves but not dichotomously branching, rarely leaf-opposed along branches (then minimum of 3 leaves between flowers); *peduncle* 2.1–12.6 mm long when flowering, spreading to recurved when fruiting, mainly with robust appressed simple hairs over usually few small stellate hairs; *bract* subtending calyx, linear-subulate, 1.1–2.5 mm long and usually less than half as long as calyx, glabrescent. *Calyx* pale to deep green more or less tinged red: *outer lobes* ovate to almost lanceolate, 2.3–4.5 mm long, acute to shortly acuminate, outer surface pubescent to puberulous with long simple appressed hairs over very few to no small stellate hairs, inner surface with few fine stellate hairs with usually 2 or 3 branches or glabrous towards the apex; *inner lobes* oblong-ovate, 2.4–5.1 mm long, obtuse to rounded, rarely mucronate or emarginate, puberulous mainly along the centre with appressed simple hairs and sometimes with small stellate hairs. *Petals* cuneate, 3.6–9.4 mm long, distinctly bilobed, bright yellow, papillose. *Stamens* (7-) 9–12 in one cluster; *filaments* usually ca half or less connate; *anthers* usually narrowly obloid, (0.8-) 0.9–1.1 (-1.3) mm or up to 1.6 mm long in the centre and usually with terminal appendage, dehiscing by pore and lateral slit. *Pistils* 2, each with 2 ±ventral, or 1 ventral and 1 basal ovule and with short style positioning stigmas below the apex of the central anthers, ovary pilose with straight erect, mainly simple hairs. *Seeds* brown to shiny-black, ca two-thirds covered by white membranous aril with short finger-like projections. *Flowers*: mainly Sept.–Dec., but with odd flowers throughout the year. *Common name*: Trailing Guinea-flower (M. Gray et al. 1993). Fig. 3A–F.

Distribution and ecology

Growing in moist habitats, often on seepage areas near creeks, on forest margins or in open forest and often associated with lower slopes of mountains in widely scattered localities in southern Victoria (EG, EHL, ?MID, OTRA) and mainly the northern, eastern and southern parts of Tasmania.

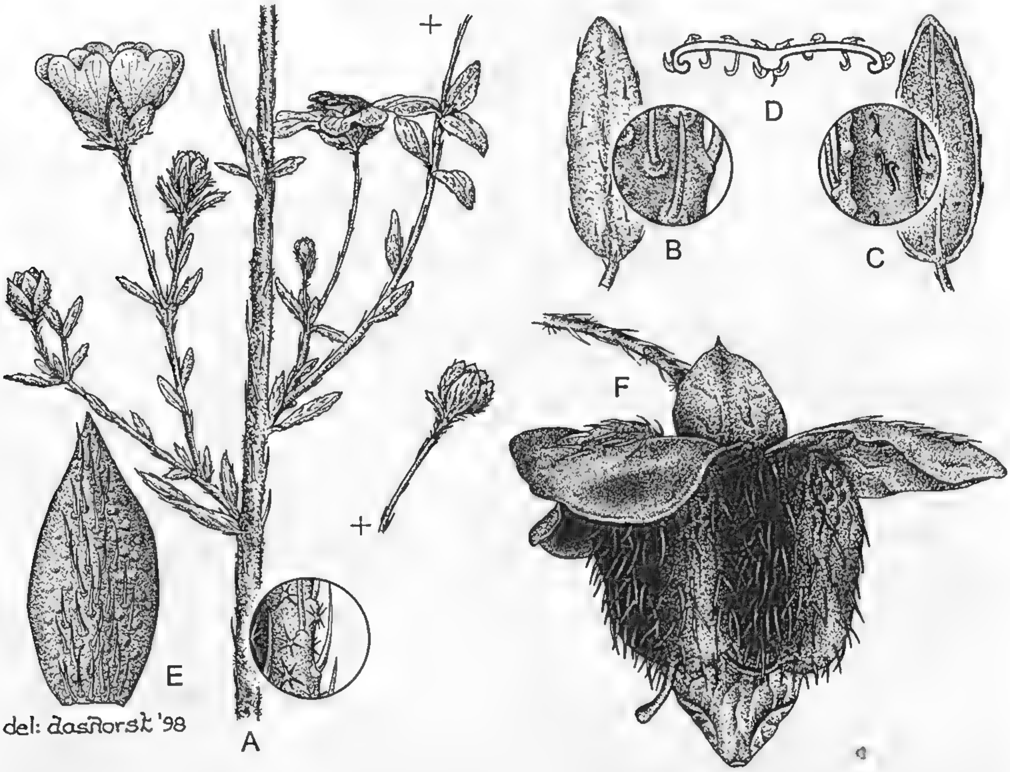

Fig. 3. ***H. appressa***. **A**, Flowering branch showing repeated flower development ×1.5; **B–D**, adult (and juvenile) leaf: **B**, above ×3; **C**, below ×3; **D**, transverse section ×9; **E**, outer calyx lobe with appressed hairs ×9; **F**, fruit showing simple hairs on follicles ×9. (**A–E**, *A.C. Beauglehole 78298*, CANB; **F**, *Blyth MEL 31467*).

Conservation status: Apparently more common in Tasmania, but there and in Victoria known from a few National Parks.

Diagnostic features

The long, often robust simple hairs which are usually appressed particularly on the lower calyx immediately distinguish this species (spreading simple hairs, if at all present, are confined to the base of calyx in *H. empetrifolia*). While no stellate hairs were observed on leaves of *H. appressa*, there are some small ones on the upper surface in *H. empetrifolia* but they wear off sooner than the simple ones. Adult leaves of the latter produce a few stellate hairs on the central vein, particularly on the lower third and the petiole but not the flanges of the stem. The distinction of *H. appressa* is supported by 8–12 stamens and mainly simple hairs on the ovary, which are clearly visible on developing fruit.

Variation

Although plants are usually decumbent ground covers with branches up to 3 m long (*W.M. Curtis HO 29326*) occasional plants will scramble into adjoining shrubs or trees, as also described for *H. pallidiflora*, and a plant 2 m high in a tree has been recorded (*A.E. Orchard 5115*).

Subwhorled flowers were observed only in specimens from Tasmania. In all Victorian plants investigated scars of reduced leaves at the base of the peduncle indicated short shoots arising usually from the first node of lateral branches.

The petals are very variable on the same plant as well as on different local plants: they vary from narrow to broadly wedge-shaped, with more or less deeply bilobed apex, and from just longer than the calyx to three times that length.

The number of stamens often varies in different populations, and the filaments are fused to varying levels, although they are usually about half, rarely only a third, connate. Similarly the length of the anthers varies considerably often even in the same flower; some have shorter outer anthers in others shorter anthers are interspersed, but in southern Tasmania all the anthers tend to be shorter than 1 mm and often oblanceolate. This local variation of all these characters could not be linked with any other characters so that no infraspecific taxa are adopted here.

Typification and nomenclature

De Candolle (1817) detected in Labillardière's collection of ***Pleurandra ovata*** two elements and he retained the name for the specimen having 10–12 stamens (G-DC). The second specimen with fewer and often unequally long anthers he named *P. scabra* var. *β*, of which a specimen also exists in the general herbarium at G (cf. taxonomic notes below). The type specimen in the Labillardière herbarium (FI) contains, according to a photograph in AD, two branches. The right hand one is less branched, the leaves are somewhat ovate and some seem to have an undulate flank typical of *H. appressa* caused by the appressed hairs. The leaves of the denser left hand specimen are more elliptic and the flowers are more hidden as normally found in *H. empetrifolia s.s.* The right hand specimen is here selected as the lectotype of *P. ovata*. Labillardiere's illustration which de Candolle (1817) also thought to belong to his *P. scabra* var. *β* (now included under *H. empetrifolia s.s.*) seems, however, judging by its more diffuse branching and exposed terminal flowers to be a poor drawing of typical *P. ovata*.

The type (*R.C. Gunn 183*) of ***Pleurandra ovata*** var. ***prostrata*** Hook.f. agrees well with the species as delineated here. The specimen *R.C. Gunn 183/1836* (K) was selected as a lectotype because this is probably the specimen J.D. Hooker examined and referred to *P. ovata* in 1840. A number of Gunn specimens with that number but collected at a later date (cf. also Buchanan, 1988) were also examined. Since J.D. Hooker (1855) quoted "P. ovata, Lab. l. c." under his "var. α. prostrata" this must become the typical variety in contrast to his and Bentham's (1863) usual format in which the species description represents at the same time the typical variety. It is not a validly published name though because it should then be an autonym (ICBN 1994: A 32.1b, A 26). This interpretation disagrees with that of Chapman (1991, p. 2325), who follows Hoogland (1974) in placing this variety under *H. empetrifolia*.

The detailed description of Mueller's ***H. billardierei***, which is to replace *Pleurandra ovata* when transferred to *Hibbertia* because of the already existing *H. ovata* Steud., was based on the following specimens of six taxa (in sequence as quoted by the author in the protologue) although details are often incompletely quoted by him:

1 Near Rivoli Bay, x.1848, *F. Mueler* MEL 31526 — ***H. pallidiflora***
1a Near Rivoli Bay, x.1848, *F. Mueller* MEL 31527 — ***H. pallidiflora***
2 Near Sealer's Cove & on Mount Hunter, v.1853, *F. Mueller* MEL 31499 —***H. hirticalyx***
3 Near Snowy River, iii.1854, *F. Mueller* MEL 31515 — ***H. appressa***
4 Ranges beyond Snowy & Broadribb rivers, i.1855, *F. Mueller* MEL 31509 — ***H. empetrifolia***
5 Glasshouse Mountains, 1855, *F. Mueller* MEL 31556 —***H. aspera*** subsp. ***pilosifolia***
6 Spencer Gulf, Memory Cove, ii.1802, *R. Brown* MEL 31491(iso) — ***H. cinerea.***

Although a detailed description is provided, none of the elements can be seen as the predominant one, so that *F. Mueller MEL 31515* was selected as lectotype because it belongs to the same species as *P. ovata*, which *H. billardierei* was to replace. Mueller (1864) referred to his var. *monadelpha* (cf. *H. hirticalyx*), but in none of his subsequent publications did he cite any of Bentham's varieties.

Chapman (1991, p. 1591) followed Hoogland (1974) in placing ***H. billardierei*** var. ***ovata*** Benth. into the synonomy of *H. empetrifolia*. Its description is very general and Bentham (1863) did not cite any specimens to establish his intention. Only one collection, *C. Stuart MEL 31471*, was inscribed by him as "Hibb. Billardierii F. Muell. γ ovata", but it contains a specimen of *H. appressa* and *H. empetrifolia* subsp. *empetrifolia*, so that it does not clearly indicate his intentions. Since he obviously agreed with Mueller's name change from *P. ovata* to *H. billardierei*, one may assume that his var. *ovata* was based on *P. ovata* in order to maintain that name. Further evidence suggesting this intention is that he states this variety to be "the most common Tasmanian and N.S.Wales form". This would, however, deviate from his normal pattern that the typical variety is represented by the type description, but it would agree with the above case of J.D. Hooker's *Pleurandra ovata* var. *prostrata*, which is not represented among Bentham's varieties, although the var. *scabra* is present but without referrence to him. Afterall Bentham himself was not conforming to this pattern when he quoted under the species, which normally would have represented the typical variety, var.*billardierei*, a number of specimens, which he also cited under different varieties below. The var. *ovata* would then, like that the var. *prostrata* (see above), be not validly published because it does not repeat the specific epithet. The following specimens (all from Tasmania) previously identified as *P. ovata* and which would fit his description of the var. *ovata*, were either initialled (MEL) by Bentham or were known to be avaible to him (Herb. Hook., K), but are not quoted in the Flora Australiensis, volume 1, p. 28, and would therefore most likely apply to this "common" taxon; they outnumber all the specimens of other taxa mentioned by Bentham.

Tasmania, 1831, *R.W. Lawrence 203* (K) (quoted in W.J. Hooker 1834, J.D. Hooker 1840, 1855);

Tasmania, 1836, *R.C. Gunn 183*, (K) (quoted in W.J. Hooker 1835, J.D. Hooker 1840, 1855));

Port Arthur, *J. Backhouse s.n.* (K) (quoted in W.J. Hooker 1835, J.D. Hooker 1840, 1855);

W. Huon River, 30.x.1839, *R.C. Gunn 183/1842* (K) (quoted in J.D. Hooker 1855);

Asbestos Hills, 24.x.1844, *R C. Gunn 183* (K) (quoted in J.D. Hooker 1855);

Recherche Bay, *R.C. Gunn 183* (K) (quoted in J.D. Hooker 1855);

South Port, xi.1855, coll.? 1761 (MEL 31474);

River Mersey, 10.I.1849, coll.? 328 (MEL 31473);

South Esk River, 1848, coll. ? 57 (MEL 31472);

Swan Port, xi. 1849, *C. Stuart 626* (2 elements on specimen MEL 31476).

It is therefore argued that circumstantial evidence shows overwhelmingly that Bentham (1863) intended to maintain J.D. Hooker's (1855) identifications of these specimens as var. *ovata* alluding to *Pleurandra ovata*. *C. Stuart 626* consists of two specimens both from Swan Port and both are initialled by Bentham. These, like MEL31471 above, might explain

the abnormal distibution records into "N. S. Wales", because Bentham did not distinguish between the two taxa here called *H. appressa* and *H. empetrifolia.* The upper specimen is a glabrescent specimen of *H. empetrifolia* as it is also sometimes found in New South Wales. Some specimens of that species, which is at times very similar to *H. appressa*, were included in Bentham's circumscription because of the "oblong leaves" in the description (cf. diagnostic features and variation of *H. empetrifolia*), but the more hairy specimens of *H. empetrifolia* were included in *H. billardierei* var. *scabra*, e.g. *Sieber, Fl. Mixta 505* (MEL 31488) is annotated by him as such.

With all specimens being equally initialled that seem to be the basis for Bentham's work, although he did not actually annotate them, the specimen *R.W. Lawrence 203* was chosen as the lectotype of this variety in preferrence to *R.C. Gunn 183*, of which there exist several collections of different dates.

Notes

It is ironic that this species, which, as *Pleurandra ovata* was the first of this group to be described, is only now receiving a legitimate name in *Hibbertia* as *H. appressa.* This is particularly poignant as Labillardière (1806) did mention in the protologue its distinguishing characters, its 9–12 stamens and appressed simple hairs on the leaves. A specimen inscribed "P. ovata Labill. – Nouv. hollandia – m. Labillardiere 1808" in G-DC shows these characteristics. However, it seems Labillardière had a mixed collection because de Candolle (1817, p. 419: *P. scabra* var. *β*) reported a second form intermediate between his *P. scabra* and *P. ovata* with almost oval leaves, acuminate calyx and 7–8 stamens. He attributed both specimens to Labillardière and the specimen of *P. scabra* var. *β* in G-DC, now identified as *H. empetrifolia s.s.*, was originally inscribed *P. ovata* without confirmation that it came originally from Herb. Labillardière. It was received by de Candolle from "m. Lambert 1816". A second specimen seen (G, general herbarium) annnotated as "Pl. ovata Labill. n.h. t143 – Nouv. holl. – herb.Labillardier – in Herbier da Moise-Etienne Moricand – dit Stefano (1779-1854)" shows similar characteristics and must also be identified as *H. empetrifolia s.s.* De Candolle (1817) also pointed out that the illustration accompanying the protologue of *P. ovata* was presumably prepared from such a specimen as it has similar almost oval leaves. Judging, however, by its more diffuse branching and exposed terminal flowers it might also be a poor illustration of typical *P. ovata.*

A.L.P.P. de Candolle (1853) then pronounced *P. ovata* a good species separate from *P. astrotricha* Sieber ex Spreng. presumably based on observations of the one type of specimen. Since Mueller (1862) had included not only *P. ovata* in his new name *H. billardierei* but all known taxa, Bentham and subsequent botanists recognised only one species in the next almost one hundred years, and the former was never again recognised as a distinct species. Even Wakefield (1957) followed by Hoogland (1974) combined it with *H. astrotricha* or *H. empetrifolia* respectively as they did not recognise that *H. appressa* (=*P. ovata*) could be distinguished by its greater number of stamens and appressed hairs as well as simple hairs on the ovary.

When Domin (1928) published the combination *H. ovata* he enumerated all the varieties recognised by Bentham (1863), but because he changed Bentham's var. *ovata* (cf. typification above) to the var. *typica* and used it as such, this indicates clearly that he had intended these varieties to be used (ICBN, A 32) and they are thus considered validly published, although the only specimen cited as var. *typica* is actually a misidentification. The species, *H. ovata* into which they had been placed was illegitimate.

Voucher specimens (134 examined)

VICTORIA: *A.C. Beauglehole 18851*, Otway Ranges, Lavers Hill, 14.xi.1959 (AD, CANB, MEL); *78298*, N.W. Glenmaggie, 10.x.1984 (AD, CANB, HO, MEL); *R.D. Hoogland 11912*, western slope of Mt Elizabeth 2, 26.xi.1970 (CANB, MEL, L, K, UC, HBG, A, G).

TASMANIA: *F.E. Davies 1068 & P. Ollerenshaw*, Dazzler Range, 19.I.1989 (AD, CANB, HO, MEL); *A. Moscal 3997*, Picketts Plains, 22.xi.1983 (AD, AK, H, HO, MEL, NLU); *M.E. Phillip CBG 15034*, near Simpsons Bay, South Bruny Island, 29.xi.1965 (AD, CANB).

H. aspera DC., Regn. Veg. Syst. Nat. 1: 430 (1817); N.A. Wakef., Vict. Nat. 73: 167 (1957), partly; N.C.W. Beadle et al., Vasc. Pl. Sydney edn 2: 230 (1972); J.H. Willis, Pl. Vict. 2. 391 (1973), partly; N.C.W. Beadle, Stud. Fl. NE New South Wales 3: 255 (1976), partly; N.C.W. Beadle *et al.*, Vasc. Pl. Sydney edn 3: 228 (1982); Stanley in Stanley & E.M. Ross, Fl. South-eastern Queensl. 1: 189 (1983); G.J. Harden & J. Everett in G.J. Harden, Fl. New South Wales 1: 293 (1990), partly; Toelken in N.G. Walsh & Entwisle, Fl. Vict. 3: 312 (1996), partly.

Type: Australia, *Caley* in Herb. Lambert (holo.: G-DC).

Shrubs with erect to decumbent or scrambling branches 0.3–1 m long, more or less branched, villous to pubescent. *Vestiture* on branches and calyx persisting, with few or no antrorsely curved simple hairs over/or usually a range of sizes of radial multiangulate stellate hairs (with (1) 2–5 (-15) often distinctly unequal, or equal branches); on *leaves above* soon wearing off, with few simple hairs, sometimes with hooked apices, or rarely stellate hairs with 1–3 unequally long branches mainly towards the base and flanks over scattered multiangulate rarely erect radial and/or rarely slightly antrose stellate hairs (4–12 similar branches) with small to broad tubercle surrounded by one ring of base cells; on *leaves below* persisting, including usually the central vein densely covered with overlapping, multiangulate radial stellate hairs (often with a few larger ones each with especially larger tubercle, among the main cover of smaller hairs) with numerous similar branches, all apparently without base cells; *juvenile leaves* below with hooked simple hairs interspersed (mainly along the major veins) with multiangulate radial stellate hairs with numerous similar branches mainly from small tubercles but broad tubercled ones get commoner as more stellate hairs are produced. *Leaves* without axillary tuft of hairs; *petiole* 0–0.8 mm long; *lamina* oblong-oblanceolate to obovate or rarely oblanceolate-cuneate, (2.8-) 5–13 (-18.7) × (1.8-) 2–5.5 (-7.4) mm, rounded or truncate to emarginate with incurved apex on young branches, rarely obtuse, usually gradually constricted into petiole, with velutinous to pilose, rarely pubescent undersurface exposed between more or less revolute margins and slightly raised central vein, upper surface pubescent to puberulous becoming glabrescent, more or less discolourous. *Flowers* abruptly constricted into the peduncle (buds obloid to ellipsoid), terminal and usually subtended by 3 subwhorled leaves, resulting in apparent di- or trichotomous branching or sometimes each of these branches is a short shoot with scale-like leaves and instead of one terminal flower producing a terminal cluster of up to 3 flowers, apparently not leaf-opposed on actively growing branches; *peduncle* (1.6-) 2–5 (-7.4) mm long and spreading when flowering, recurved when fruiting, pubescent to velutinous mainly with radial stellate hairs; *bract* subtending calyx, linear-subulate, 1.2–1.5 (-1.8) mm long, usually one-third to two-thirds of calyx, velutinous. *Calyx* greyish-green; *outer lobes* ovate rarely lanceolate, (2.7-) 3–3.8 (-4.1) mm long, usually shortly acuminate, outer surface pubescent to velutinous, rarely pilose (usually larger stellate hairs with unequal branches over smaller regular ones), inner surface with few fine stellate hairs each usually with 2 or 3 antrorse branches on upper third; *inner lobes* oblong-ovate, (2.9-) 3.3–4 (-4.2) mm long, more or less rounded, tomentose to velutinous, rarely pubescent. *Petals* oblanceolate to almost narrowly obtriangular, (3.1-) 3.4–5 (-6.2) mm long, bilobed, more or less papillose on inside. *Stamens* (2-) 4–6 (-9) in one cluster; *filaments* connate for half their length or more; *anthers* obloid to obloid-obovoid, (0.7-) 1–1.2 mm long, usually without terminal appendage, dehiscing by apical pore and introrse

slits. *Pistils* 2, each with 2 basal ovules, or 1 ventral and I basal, and with style positioning the stigmas below the apex of the central anthers; ovary shaggy with erect stellate hairs each usually with more than 3 branches. *Seeds* brown to shiny-black, usually ca two-thirds, rarely completely covered by white membranous aril ending in shorter or longer finger-like projections.

Diagnostic features

H. aspera is distinguished from most of the species in this group by its 4–7(-9) stamens, which it shares with *H. empetrifolia*, but from which it is distinguished by its usually dense stellate indumentum on the undersurface of adult leaves. Even if the stellate hairs are not dense on some local forms or on juvenile leaves they are distributed at random, while on leaves of *H. empetrifolia* stellate hairs only occur along the central vein, rarely just next to it or a few along secondary veins. Radial multiangulate stellate hairs are usually common on the upper surface of leaves of *H. aspera* while stellate hairs on lower leaf surface of *H. empetrifolia* are usually antrorsely inclined and rare if at all present. Some flowering specimens from Queensland, e.g. *R.D. Hoogland 11798*, have been included in *H. aspera* subsp. *aspera* because of these radial stellate hairs on the adaxial leaf surface in spite of just a few stellate hairs and mainly hooked ones on the undersurface, which in other specimens grade into the typical variety. These plants are interpreted as plants retaining for one or other reason their juvenile characters and more information is needed. Stellate hairs on the ovary of *H. aspera* tend to have three or more branches while there are usually only two in *H. empetrifolia.*

Leaves of the subsp. *pilosifolia* are easily distinguished from those of the typical subspecies by their erect stellate hairs usually with few unequally long branches on both surfaces of the leaves. This is particularly noticable on the upper surface, because here the stellate hairs of subsp. *aspera* have a number of depressed equal branches.

Variation

H. aspera, like *H. empetrifolia,* shows much variation in different local populations as well as sometimes on the same plant. Basically a northern and a southern form can be recognised from about Newcastle. While the southern form seems to comprise of individuals which have foliage which changes abruptly into adult leaves with stellate-velutinous undersurface, various intermediates between the juvenile and adult forms with few to many stellate hairs on the leaf undersurface persist for longer or shorter periods in northern New South Wales and adjoining Queensland. The trend is from a dense to a sparser indumentum of particularly the stellate hairs on the undersurface of leaves, but also to fewer simple hairs on all parts of the plant. The space between individual stellate hairs also increases because the hairs tend to have shorter branches (rarely longer than 0.1 mm) although in some plants they still become velutinous on the uppermost leaves. The difference between phenotypic (the frequent retention of juvenile characters apparently due to environmental conditions), as opposed to genotypic variations (local forms), cannot be assessed from the limited herbarium material examined except for the more obvious subsp. *pilosifolia* (see below). Many records are from isolated mountain ranges. For instance, the most northern record of this subsp. *aspera*, a single specimen from the Paluma Range (*B.R. Jackes 8720*), has many hairs on the leaves and branches with unevenly long branches as in subsp. *pilosifolia*, but since they are not erect and on few leaves have at least five radial branches, as well as the presence of many hooked hairs on leaves below and sometimes even above, as it is sometimes found in some Queensland specimens, it was provisionally placed into subsp. *aspera*, but does not fit well there. The very short petals, apparently always shorter than the sepals is unique in the species (cf. *H. pallidiflora*).

The southern form is much more uniform except for the broad, often obovate leaves on fast growing branches in contrast to those on older ones. However, among those narrow-

leaved plants there are some with oblong ones, which have mainly longer and short simple hairs with usually very few, antrorsely inclined stellate hairs among the latter. These leaves resemble those of *H. empetrifolia* except for the stellate hairs moderately to densely covering the undersurface, but the significantly abnormal pollen indicates that these are probably hybrids (see below). These leaves are very similar to juvenile leaves (e.g. *E. Gauba CBG 4804*, *E.F. Constable NSW 42822*), as in the southern form they have simple hairs mixed with antrorsely inclined stellate on the upper leaf surface, but the lower leaf surface is always covered with more or less dense stellate hairs. The latter have, however, fewer branches, but juvenile leaves with hooked simple hairs as known from the northern form have not been observed in the south. These juvenile leaves must not be confused with what seem to be shade forms (e.g. *E. Gauba CBG 4800*, *A.C. Beauglehole 62491*) where radial and antrorsely inclined stellate hairs are mixed on the upper suface of the leaves and both types have often few, unequally long branches.

The length of the peduncle is particularly short in subsp. *pilosifolia* and flowers appear to be axillary, because they are commonly borne on such reduced short shoots, or clusters of short shoots, each with scale-like leaves in the leaf axils along the main branches. Also its flowers tend to be smaller and were sometimes identified as *H. billardierei* var. *parviflora*, but the type of that variety comes from near Sydney and is synonymous to subsp. *aspera*. Short peduncles, clustered flowers in the leaf axils and small flowers are also found in some forms of subsp. *aspera*.

Notes

Most publications since Wakefield (1957) include a number of other taxa with hairy undersurfaces of the leaves in their *H. aspera*, but it is usually not possible from the description to assess which taxa were included, as usually no specimens were annotated. Only in local floras can the range of material included be geographically evaluated. Judging by the description of the shape of the leaves and their indumentum Bailey (1899), for instance, must have had specimens of both these Queensland subspecies in his concept of *H. billardierei*. Similarly *H. aspera* of T. Stanley (1983) seems to have included specimens of two subspecies while the photograph published by S. & A. Pearson (1991) must be placed in subsp. *pilosifolia*.

Stebbins & Hoogland (1976, p.148) recorded the chromosome number 2n = 36 "in *H. aspera* DC. from Victoria", but since they did not cite a specimen this count could refer to one of five species with densely hairy lower leaf surface, as it seems from Hoogland (1974) and some identifications that he followed Wakefield's broad concept of that species.

For key to the subspecies see key to the species, pp. 118, 120.

subsp. **aspera.**

H. aspera DC., Regn. Veg. Syst. Nat. 1: 430 (1817); N.A. Wakef., Vict. Nat. 73: 167 (1957), partly; N.C.W. Beadle *et al.*, Vasc. Pl. Sydney edn 2: 230 (1972); J.H. Willis, Pl. Vict. 2. 391 (1973), partly; N.C.W. Beadle, Stud. Fl. NE New South Wales 3: 255 (1976), partly; N.C.W. Beadle *et al.*, Vasc. Pl. Sydney edn 3: 228 (1982); G.J. Harden & J. Everett in G.J. Harden, Fl. New South Wales 1: 293 (1990), partly; Toelken in N.G. Walsh & Entwisle, Fl. Vict. 3: 312 (1996), partly.

Type: as for *H. aspera*.

Pleurandra parviflora R. Br. *ex* DC., Regn. Veg. Syst. Nat. 1: 418 (1817).

Type: New South Wales, near Port Jackson, *R. Brown s.n.* (lecto. – selected here: G-DC; syn.: *Lechenault s.n.*, *n.v.*, cf. typification).

P. cinerea auct. non R. Br. *ex* DC.: Sieber, Fl. Nov. Holl. No. 139.

Hibbertia billardierei F. Muell., Pl. Indig. Col. Vict.. 1: 14 (1862), partly, as for *P. parviflora*, "*Billardierii*"; F.M. Bailey, Syn. Qld Fl. 4 (1883), partly, "*Billardieri*"; Qld Fl. 1: 13 (1899), partly, "*Billardieri*"; Comp. Cat. Qld Pl. 21 (1913), partly, "*Billardieri*", *nom. illeg., nom. superfl.*

H. billardierei F. Muell. var. *parviflora* (R. Br. *ex* DC.) Benth., Fl. Austr. 1: 28 (1863), partly.

Type: as for *P. parviflora*.

H. billardierei F. Muell. var. *obovata auct. non* R. Br. *ex* Benth.: Benth., Fl. Austr. 1: 28 (1863), as for "Hastings river, Beckler" MEL 31567 (see also *H. hirticalyx*: typification).

H. ovata (Labill.) Druce var. *parviflora* (R. Br. *ex* DC.) Domin, Biblioth. Bot. 89: 422 (1928); Ewart, Fl. Vict. 769 (1931), partly.

Type: as for *P. parviflora*.

Shrubs up to 0.6 m high unless scrambling, rarely with robust branches covered with more or less simple and stellate hairs usually of varying sizes but with equal branches. *Leaves* above pubescent to puberulous, becoming glabrous with ±smooth tubercles, with often depressed radial stellate hairs (5–9 equal, rarely unequal branches), with few, rarely none, much longer simple hairs mainly towards the base and the flanks; below velutinous, rarely pubescent, with usually strongly overlapping radial stellate hairs (8–many branches 0.05–0.4 (-0.6) mm long, or if surface visible between hairs then branches up to 0.2 mm long), and a few longer simple hairs on the flanks and along the central vein but frequently absent; juvenile leaves above with erect or antrorsely inclined simple and stellate hairs (1–3 often unequal branches), below pubescent, with often scarcely overlapping erect to radial stellate hairs (5–14 equal branches, usually less than 0.2 mm) and rarely with few hooked simple hairs between. *Flowers* 1, 2 (3), terminal on all branches including short shoots. *Flowers*: mainly Sept. – Dec., but occasionally until March. Figs. 1B; 2F–I; 4A–K.

Distribution and ecology

Rarely common but found in a wide range of habitats (sometimes with *H. empetrifolia*) ranging from sandstone to quartzite or sandy soils and apparently somewhat salt tolerant, in woodland or forest, often on forest margins or sclerophyll forest, mainly on the eastern or south-eastern slopes of the Great Divide in Queensland (Nk, Le, Wb, Mo), New South Wales (NC, CT, CC, ST, SC) and Victoria (EG, GPL, EHL).

Conservation status: Widespread but never common, recorded from parks in all three of the above States.

Variation

This is the most widespread subspecies and has the widest range of variation particularly the indumentum, the size and shape of leaves, the clustering of flowers and the often very short peduncle (see variation under species).

Typification

The specimen of R. Brown, who had suggested the name *Pleurandra parviflora*, was selected as the lectotype of this species. No Leschenault specimen (other syntype) could be found in de Candolle's collection, and, since it is very unlikely that de Candolle had annotated the specimens he had seen elsewhere, it will be difficult to prove that any Leschenault specimen found in another herbarium was the specimen examined by de Candolle.

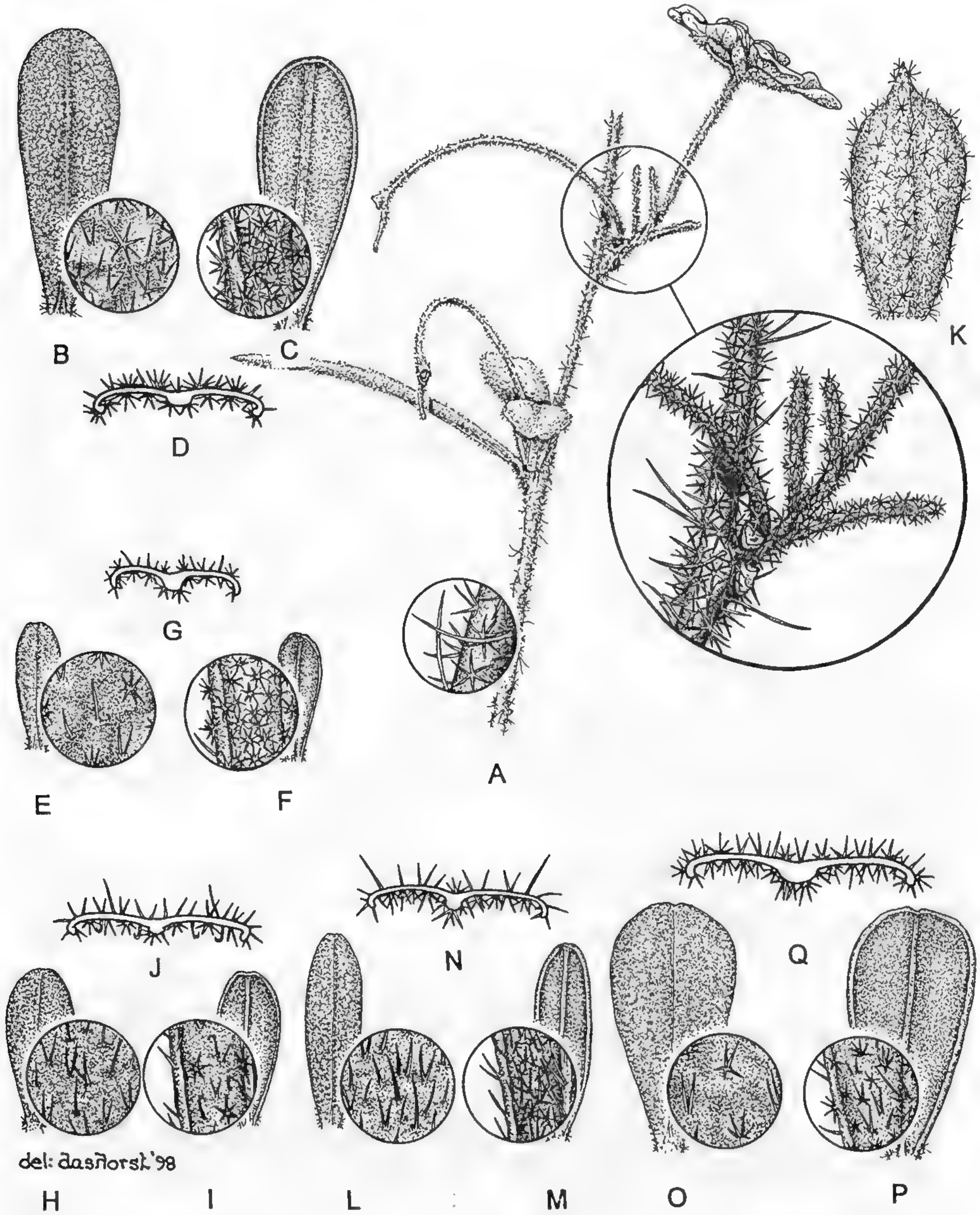

Fig. 4. ***H. aspera*** supsp. ***aspera***. **A**, Branch with flowers terminal on short shoots, sometimes repeated with three reduced leaves at the base ×3; **B–D**, adult leaf: **B**, above ×3; **C**, below ×3; **D**, transverse section ×5; **E–G**, intermediate stage leaf: **E**, above ×3; **F**, below ×3; **G**, transverse section ×8; **H–J**, juvenile leaf: **H**, above ×3; **I**, below ×3; **J**, transverse section ×8; **K**, outer calyx lobe ×9. ***H. aspera*** subsp. ***aspera*** × ***H. empetrifolia*** subsp. ***empetrifolia***. **L–N**, adult leaf: **L**, above ×3; **M**, below ×3; **N**, tranverse section ×12. ***H. aspera*** subsp. ***pilosifolia***. **O–Q**, adult leaf: **O**, above ×3; **P**, below ×3; **Q**, transverse section ×6. (**A–D**, *J.L. Boorman NSW 102176*; **E–K**, *C.T. White BRI 10502*; **L–N**, *C. Tyrrel 129*, CANB; **O–Q**, *R.J. Henderson 1040*, BRI).

Voucher specimens (208 examined)

QUEENSLAND: *L.H. Bird AQ 409169*, Woogaroo Creek, Goodna, 1.ix.1988 (BRI); *C.E. Hubbard 3876*, Tugun, 5-7.ix.1930 (BRI, K); *B.R. Jackes 8720*, E "Taravale", Paluma Range, 22.iii.1987 (BRI); *I.R. Telford 5515*, ca 8 km SE Amys Peak, Kroombit Tableland, 4.vi.1977 (CANB).

NEW SOUTH WALES: *B.J. Conn 3101 & A. Scott*, 2.3 km SE Silverdale, 24.v.1989 MEL, MO, NSW); *M. Evans 2485*, Kioloa State Forest, 11.x.1966 (A, BRI, CANB, K, L, MEL, NSW); *R.D. Hoogland 11772*, near Coralville, 8.ix.1970 (A, CANB, K, L, NSW).

VICTORIA: *A.C. Beauglehole 50273*, 21.5 km SSE Gormandale, 2.x.1975 (CANB, MEL); *72387*, Moondarra State Park, 6.xii.1982 (MEL); *J.H. Ross 3497*, 5 km NW Mallacoota, 21.x.1991 (AD, BRI, CANB, HO, MEL, NSW, RSA, S).

Putative hybrids

H. aspera* subsp. *aspera* × *H. empetrifolia* subsp. *empetrifolia

While these specimens have the dense stellate-velutinous undersurface of the leaves of *H. aspera* subsp. *aspera*, their upper surface is sparsely covered mainly with short and longer spreading simple hairs, and only occasionally are found some much shorter, antrorsely-inclined stellate hairs with 1–3 branches. Not only the hairs on the upper surface but also the oblong to oblong-oblanceolate shape of the leaves is reminiscent of those of *H. empetrifolia*. Their hybrid nature is indicated by a high percentage of abnormal pollen in most specimens except for one collection from Thirlmere, Picton Lakes (*E.J. McBarron 8762*), which unlike specimens of *H. notabilis*, has few short stamens like other specimens of *H. aspera* subsp. *aspera* from near Picton. This single collection was provisionally determined as the above hybrid for lack of other distinguishing characters. These specimens must be distinguished from presumed shade forms of *H. aspera* subsp. *aspera*, which also have at least some stellate hairs with radially arranged branches on the upper leaf surface of adult leaves. Detailed field observations are needed.

In their notes accompanying these specimens none of the collectors mentioned that they suspected hybrids or recorded plants of the other species from the area. However, M.E. Pillips made two collections along the track to Green Cape lighthouse without commenting (see below). Yet several mixed collections found in herbaria indicate that the two species often grow near one another, and, although no such specimens have been recorded from areas where these hybrids have been found, herbarium collections of both species from these general areas are cited below to show that they do occur there.

Specimens examined

H. aspera* subsp. *aspera* × *H. empetrifolia* subsp. *empetrifolia

NEW SOUTH WALES: *E.J. Mc Barron 8762*, Thirlmere, Picton Lakes, 27.i.1964 (NSW), 14% abnormal pollen; *M.E. Phillips CBG 4840*, track to Green Cape, approaching lighthouse, 8.x.1961 (CANB), 45% abnormal pollen; *C. Tyrrel 129*, 3.8 km NE Tanja, 28.viii.1978 (CANB), 68% abnormal pollen.

H. aspera* subsp. *aspera

NEW SOUTH WALES: *E.F. Constable NSW 30129*, Disaster Bay, near Bay Cliffs, 8.x.1954 (CANB), 0% abnormal pollen; *F.A. Rodway NSW 88039*, near Green Cape, -.xii,1920 (NSW), 3% abnormal pollen; *M. Mueller 2203*, E Bega, 17.x.1953 (NSW), 1% abnormal pollen; *G. Stewart 163 & P. Whigham*, 6.4 km E of Bega on road over Dr George Mountain, 9.x.1984 (CANB), 0% abnormal pollen.

H. empetrifolia* subsp. *empetrifolia

NEW SOUTH WALES: *M.E. Phillips CBG 4841*, track to Green Cape, 8.x.1961 (CANB), 1% abnormal pollen; *J. Pulley 426*, ca 1 km W Tathra, 20.v.1970 (CANB), 0% abnormal pollen; *493*, Green Cape, 1 km W of lighthouse, 21.v.1970 (CANB), 1% abnormal pollen; *501*, Green Cape, 7 km W of lighthouse, 21.v.1970 (CANB), 0% abnormal pollen.

subsp. **pilosifolia** Toelken, *subsp. nov.*

H. billardierei F. Muell., Pl. Indig. Col. Vict. 1: 14 (1862), partly as for syntype: Glasshouse Mountains, *F. Mueller MEL 31556* (cf. typification: *H. appressa*), "*Billardierii*"; F.M. Bailey, Syn. Qld Fl. 4 (1883), partly, "*Billardieri*"; Qld. Fl. 1: 13 (1899), partly, "*Billardieri*; Comp. Cat. Qld Pl. 21 (1913), partly, "*Billardieri*" , *nom. illeg., nom. superfl.*

H. aspera auctt. non DC.: Stanley in E.M. Ross & Stanley, Fl. SE Queensland 1: 189 (1983), partly; S. & A. Pearson, Pl. Central Qld 223 (1991), fig.

A subspeciebus aliis pilorum stellatorum ramis paucis erectis in foliis supra et subtus differt.

Type: Queensland, Atherton Tablelands, Wallum trig track, *J.M. Powell 680 & J. Armstrong* (holo.: NSW; iso: BRI).

Shrubs 0.6–1 m high, with spreading, often robust branches covered with similar stellate hairs with unequal branches and occasionally with simple hairs. *Leaves* above pilose-pubescent becoming glabrous with raised tubercles ('goosebumps'), with erect radial to antrorsely curved stellate hairs (1–3 (4) usually unequal branches) and more or less simple hairs mainly towards the base and the flanks; below pilose to pilose-velutinous with scarcely overlapping erect radial stellate hairs (2–5 ± equal branches 0.3–0.7 mm long) and few simple hairs along the flanks and central vein; juvenile leaves or leaves around inflorescences with slender erect stellate hairs restricted to major vein and with some hooked simple hairs between them. *Flowers* 1, 2 (3), terminal mainly on short shoots. *Flowers*: mainly Aug.–Nov. Fig. 4O–Q.

Distribution and ecology

Growing usually in forests or heath and often associated with rock screes, widespread in often more temperate areas along the Great Divide of Queensland (Co, Le, Mo) from the Atherton Tablelands southwards along scattered localities into northern New South Wales (NT, NC).

Conservation status: Recorded mainly from isolated areas in mountains which are protected parks or forestry reserves.

Diagnostic features

This subspecies is easily distinguished from *H. rhynchocalyx* which is also found in the Gibraltar Ranges, by only 4–7 anthers without terminal appendages. Even vegetatively they can be recognised by relatively short erect hairs, which are more or less of the same length on the upper surface of leaves (cf. up to eight times as long in *H. rhynchocalyx*), and stellate hairs have 1–3 (4) branches in the subsp. *pilosifolia* and (4) 5–7 branches in the latter species. The tubercles of all hairs on the upper leaf surface of leaves of this subspecies are always raised so as to give the impression of 'goosebumps' on human skin, a phenomenon also visible on 'juvenile' leaves and in some plants of subsp. *aspera*.

Etymology

The epithet 'pilosifolia', Latin, 'pilose-leaved', refers to the rough appearance of the indumentum of visibly separate soft erect stellate hairs on both surfaces of the leaves. The effect of separate hairs is enhanced by usually unequally long branches and the raised tubercles of these stellate hairs.

Voucher specimens (23 examined)

QUEENSLAND: *S.T. Blake 21344*, Shipstern Range, 19.viii.1960 (CANB, BRI, NSW); *R.J. Henderson et al.1040*, bed of Rainbow Creek ca 0.4 km from falls, Blackdown Tableland, 6.ix.1971 (BRI, NSW); *C.E. Hubbard*

4217, Springbrook, Macpherson Range, 28.ix.1930 (BRI, K); *J.M. Powell 680 & J. Armstrong*, Wallum trig track, Atherton Tablelands, 9.ix.1977 (BRI, NSW).

NEW SOUTH WALES: *H Streimann 8163*, Chaelundi Mountain, 14.x.1978 (CANB); *C. Stuart 246, 269, 495, 559*, Sandy Creek, Timbarra, s.d. (MEL); *I.R. Telford 1340*, Mt Spirabo road, 31.viii.1969 (CANB).

H. cinerea (R. Br. *ex* DC.) Toelken, *comb. nov.*

Type: South Australia, Eyre Peninsula, Memory Cove, *R. Brown s.n.* (holo.: G-DC; iso: MEL, NSW).

Pleurandra cinerea R. Br. *ex* DC., Regn. Veg. Syst. Nat. 1: 417 (1817).

Pleurandra sericea Hook.f., Fl. Tasm. 1: 16 (1855), partly as for *P. cinerea.*

H. billardierei F. Muell., Pl. Indig. Col. Vict. 1: 14 (1862), partly, as for syntype: Spencer Gulf, Memory Cove, *R. Brown MEL 31491* (cf. typification: *H. appressa*), "*Billardierii*", *nom. illeg., nom. superfl.*

H. densiflora (Hook.) F. Muell., Pl. Indig. Col. Vict. 1: 15 (1862), partly as for *Pleurandra cinerea*, nom. illeg.; Tate, Proc. Trans. Roy. Soc. S. Austr. 4: 104 (1882), "Port Lincoln".

H. billardierei F. Muell. var. *scabra* (R.Br. *ex* DC.) Benth., Fl. Austr. 1: 28 (1863), partly, as for *P. cinerea.*

Hibbertia sericea (R. Br. ex DC.) Benth., Fl. Austr. 1: 26 (1863), partly as for *Pleurandra cinerea.*

H. ovata (Labill.) Druce var. *scabra* (R. Br. *ex* DC.) Domin, Biblioth. Bot. 89: 422 (1928), partly, as for *P. cinerea.*

H. sericea (R. Br. *ex* DC.) Benth. var. *cinerea* (R. Br. *ex* DC.) J.M. Black, Fl. S. Austr. 575 (1952).

Type: as for *P. cinerea.*

H. aspera auctt. non DC.: N.A. Wakef., Vict. Nat. 73: 167 (1957); H. Eichler, Suppl. Fl. S. Austr. 226 (1965); Hoogland, Kew Bull. 29: 155 (1974); Jessop in Jessop & Toelken, Fl. S. Austr. 1: 355 , partly, as for *P. cinerea.*

H. sp. A Toelken in Jessop, List Vasc. Pl. S. Austr. edn 4, 28 (1993).

Shrubs with erect or spreading branches, 0.3–1.2 (-2) m tall, usually densely branched, velutinous, rarely tomentose. *Vestiture* on branches, adult leaves and calyx persisting, of few to many erect radial/antrorse stellate hairs (1–5 (-8) often unequal branches) each on a small tubercle, over usually overlapping multiangulate radial stellate hairs (5–9 (-15) similar branches), each commonly on a small tubercle base but also some scattered ones with much broader tubercles especially on the upper flanks and central vein of leaves, but then often larger and with many branches more or less over or between the former, all of them with indistinct base cells; on *leaves above* and *below* similar; on *juvenile leaves* (e.g. *C.R. Alcock 625*) above with erect to forward-directed or radial stellate hairs with (1-)2–3 (-5) branches, below mainly with hooked simple hairs without tubercle bases except for stellate hairs along the central vein and on the flanks, but simple hairs becoming gradually replaced by a sparse cover of stellate hairs with few branches then a dense cover with stellate hairs each with usually more than 10 branches. *Leaves* without axillary tuft of hairs; *petiole* 0.4–1.2 mm long; *lamina* oblanceolate-elliptic, narrowly elliptic to elliptic-oblanceolate, rarely obovate, (3.2-) 6–10 (-16.3) × (1.5-) 2.5–4 (-6.6) mm, obtuse or rounded, rarely truncate or emarginate, usually gradually constricted into petiole, with more or less revolute margins but undersurface exposed between them and the more or less raised central vein, above densely pubescent to velutinous, rarely glabrescent with age, below puberulous when juvenile, becoming velutinous to densely pubescent on adult leaves, often equally densely hairy on both surfaces or rarely slightly denser below, grey-green, rarely slightly discolourous. *Flowers* abruptly constricted into the peduncle (buds obloid to broadly ellipsoid before opening), terminal on branches but apparently without short shoots, usually subtended by 3 subwhorled leaves, sometimes leading to dichotomous branching but repeating flowering in the same season not common, rarely leaf-opposed along young branches (then a minimum of 4 but usually more leaves between flowers); *peduncle* (2.5-) 3.5–6 (-7.3) mm long and spreading when flowering, recurved when fruiting, pubescent (usually larger over smaller stellate hairs); *bract* subtending calyx, linear-subulate or rarely

linear-lanceolate, 2.8–5.1 mm, usually two-thirds to as long as calyx, velutinous. *Calyx* greyish-green rarely tinged purple; *outer lobes* ovate rarely lanceolate, 3.1–5.2 mm long, shortly acuminate, outer surface villose to pubescent (often irregular larger stellate hairs over smaller regular one), inner surface with few fine antrorse stellate hairs with ususally 2 or 3 branches on the upper third; *inner lobes* oblong-ovate, 3–5.3 mm long, usually rounded or outermost mucronate, tomentose to pubescent. *Petals* broadly obovate, 5.2–12 mm long, truncate, emarginate or rarely shallowly bilobed. *Stamens* 9–12 in one cluster; *filaments* usually connate up to half their length; *anthers* norrowly obloid, 1.2–1.7 mm long, with short terminal appendages sometimes on inner anthers, dehiscing mainly by introrse slits. *Pistils* 2, each with 2 ventral ovules and with terminal style positioning the stigmas near the apex of the central anthers, ovary shaggy with erect, mainly stellate hairs. *Seeds* brown to shiny-black, ca 2.3 × 2.6 mm, with lobed, rarely finger-like membranous aril covering about two-thirds of seed. *Flowers*: Aug.–Dec. Figs. 1A; 5A–K.

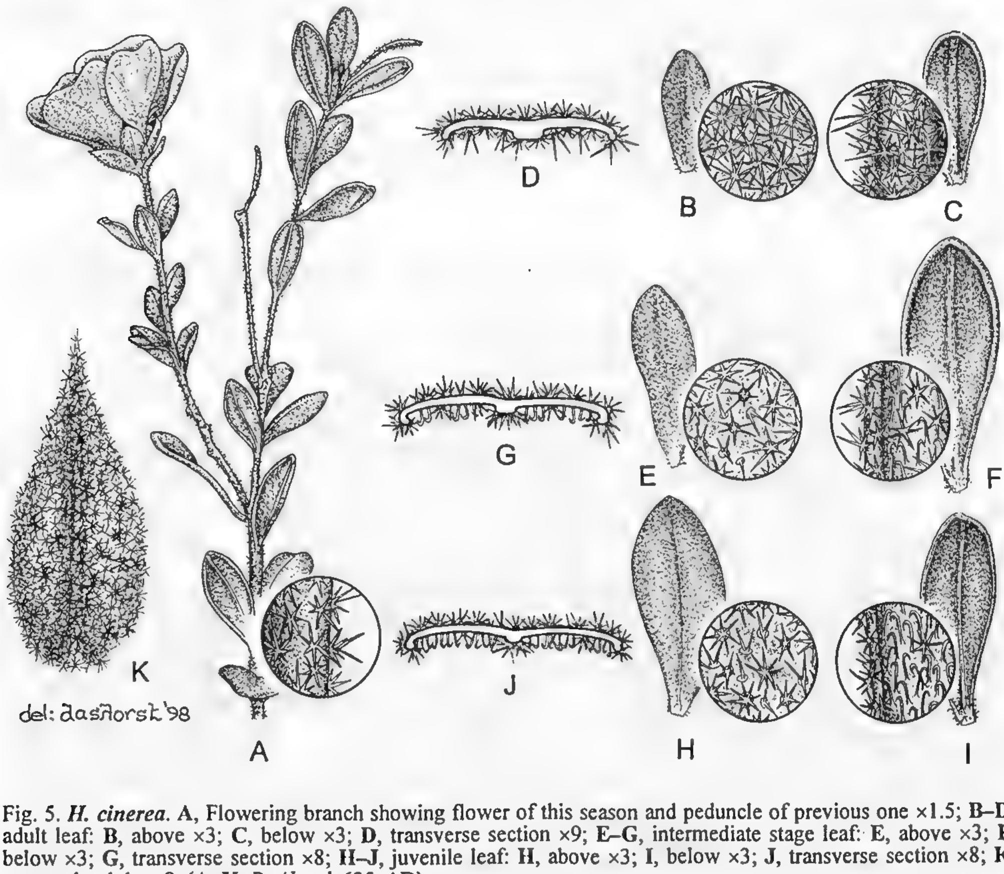

Fig. 5. ***H. cinerea.*** **A**, Flowering branch showing flower of this season and peduncle of previous one ×1.5; **B–D**, adult leaf: **B**, above ×3; **C**, below ×3; **D**, transverse section ×9; **E–G**, intermediate stage leaf: **E**, above ×3; **F**, below ×3; **G**, transverse section ×8; **H–J**, juvenile leaf: **H**, above ×3; **I**, below ×3; **J**, transverse section ×8; **K**, outer calyx lobe ×9. (**A–K**, *R. Alcock 625*, AD).

Distribution and ecology

Grows usually on sandy soil often with limestone outcrops in more or less coastal scrub to low mallee vegetation on the southern point of Eyre Peninsula, South Australia.

Conservation status: Although restricted in its distribution *H. cinerea* is locally common and conserved in Lincoln National Park.

Diagnostic features

Both *H. cinerea* and *H. hirticalyx* have 9–12 stamens with oblong anthers of similar size, 1.2–1.7 mm long and without apical appendages. The bracts subtending the base of the flowers are about as long as the calyx. In both these species it seems the undersurface of the juvenile leaves are covered with more or less hooked hairs while they become covered more or less densely by stellate hairs similar to those of *H. pallidiflora*, which in turn is distinguished by its characteristic short tubular corolla and styles longer than the stamens.

H. cinerea is distinguished from *H. hirticalyx* by the smooth appearance resulting from larger stellate hairs over smaller ones while the long simple hairs over smaller stellate hairs give the latter species and in particularly the calyx a very hairy appearance. The linear bracts of the latter are rarely broader than 0.25 mm while they are broader in the former. *H. cinerea* is, like *H. pallidiflora,* usually associated with limestone while *H. hirticalyx* prefers acid soils derived from granite or sandstone.

Occasionally vegetative material of this subspecies is confused with similarly stellate-tomentose *H. incana*, which also occurs in the vicinity of Port Lincoln, but which has long fine simple hairs over stellate ones, a broad central ridge and usually grows in association with granite or quartzite outcrops, while flowering material has usually clustered, sessile flowers and fruit. This confusion between these species of different groups is shown by Black's combination *H. sericea* var. *cinerea.*

Variation

The size of the plants is usually about 1 m tall but when in competition with other shrubs it often attains a height of 2 m.

Notes

Although this species produces terminal flowers on a similar fascicled branch apex with usually three subwhorled leaves subtending it, it does not produce the two scale leaves at the base of each peduncle, nor were short shoots recorded similarly abbreviated to those found in *H. aspera.*

Voucher specimens (35 examined)

SOUTH AUSTRALIA: *J.D. Briggs 1188*, 1 km SE Winters Hill, Port Lincoln, 16.xi.1983 (AD, CANB, NSW); *1288*, ca 20 km S Port Lincoln South, 1.x.1983 (AD, CANB, MEL, NSW); *E.M. Canning 5330*, 15.4 km from Wanilla to North Shields, 2.xii.1982 (CANB, MEL); *N. Donner 11133*, Taylors Landing , 4.xi.1985 (AD, BRI, CANB, K, MEL, PERTH).

H. decumbens Toelken, *sp. nov.*

H. astrotricha auct. non (Sieber *ex* Spreng.) N.A. Wakef.: N.C.W. Beadle *et al.*, Vasc. Pl. Sydney edn 2: 230 (1972), partly.

H. empetrifolia auctt. non (R. Br. *ex* DC.) Hoogland: Hoogland, Kew Bull. 29: 155 (1974), partly; N.C.W. Beadle *et al.*, Vasc. Pl. Sydney edn 3: 229 (1982), partly; G.J. Harden & J. Everett in G.J. Harden, Fl. New South Wales 1: 302 (1990), partly.

H. empetrifoliae similis foliis subtus pilis uncatis sed 9–15 staminibus antheris linearibus 1–1.2 mm longis et foliis plerumque obovatis differt.

Type: New South Wales, near Wentworth Falls, *F.E. Davies 353 & T. Mulcahy*, 3.xii.1987 holo.: CANB; iso.: MEL, NSW).

Shrublets with spreading to prostrate branches up to 0.4 m long, usually much branched, pubescent to puberulous. *Vestiture* on calyx outside with multiangular radial stellate hairs (2,3 (4) usually unequal branches) with fine tubercles and apparently no base cells, or

simple hairs over small stellate hairs (2,3 similar branches) and/or hooked hairs, on inside outer calyx lobes glabrous with a few fine scattered simple hairs towards the upper flanks; on branches with few larger erect to multiangulate radial stellate hairs (1–3 usually unequal branches) with small tubercles over numerous smaller multiangulate radial stellate hairs (with 2, 3 (–5) branches) with small tubercles; on *leaves above* with erect robust simple hairs with few base cells over delicate erect hooked hairs without base cells; on *leaves below* with fine erect hooked simple hairs and along central vein usually with a few robust simple hairs as above sometimes over small multiangulate radial stellate hairs (2–5 similar branches) with small tubercles especially along the central vein; *juvenile leaves* unknown. *Leaves* without axillary tuft of hairs; *petiole* (0.2-) 0.4–1 (-1.6) mm long; *lamina* obovate, broadly elliptic to almost orbicular, (2.6-) 4.2–8.5 (-10.4) × (1-) 2.5–6 (-7.6) mm, obtuse to rounded and mucronate, rarely acute, abruptly constricted into petiole, with scarcely recurved to revolute margins often more or less unequally recurved but undersurface exposed between them and the more or less raised central vein, puberulous to glabrescent, discolourous. *Flowers* abruptly constricted into peduncle (buds obovoid before opening), terminal on branches (very rarely short shoots present), leaf-opposed along main branches and apparently with single flower per branch per season, occasionally with (2) 3 subwhorled leaves; *peduncle* (3.5-) 5–10 (-12.4) mm long and spreading when flowering, not elongating and more or less recurved when fruiting, usually stellate–pubescent; *bracts* subtending calyx, linear-subulate, (0.8-) 1.1–1.5 (-1.8) × 2–3 mm, rarely up to half as long as calyx, stellate-puberulous. *Calyx* with *outer lobes* ovate, 3.3–4.2 mm long, acute to shortly acuminate, outer surface pubescent, inner surface glabrous or with a few scattered antrorse hairs with 1-3 branches on the upper third; *inner lobes* broadly oblong-ovate, 3.4–4.4 mm, rounded or outermost mucronate, pubescent. *Petals* obovate-cuneate, 3.8–7.2 mm long, more or less bilobed, bright yellow. *Stamens* 9–12 (-15) in one cluster; *filaments* connate usually at least half their length; *anthers* narrowly obloid, 1–1.2 mm long, with indistinct terminal appendages on central ones, dehiscing mainly by lateral slits. *Pistils* 2, each with 2 parietal ovules and with styles positioning the stigmas below the apex of the inner anthers, ovary tomentose to shaggy, with erect or spreading stellate hairs. *Seeds* unknown. *Flowers*: mostly Oct.–Jan., but occasionally recorded throughout the year. Fig. 6A–E.

Distribution and ecology

Grows on sandstone ledges but known only from a few localities in New South Wales (CT).

Conservation status: unknown, and few recent records.

Diagnostic features

The usually more than 10 stamens with linear anthers 1–1.2 mm long, and obovate leaves places *H. decumbens* in a complex with *H. cinerea*, *H. hirticalyx* and *H. pallidiflora*, but it is distinguished by the absence of stellate hairs on the undersurface other than on the central vein of adult leaves as well as by the hooked simple hairs on the calyx. Also its prostrate to decumbent habit is characteristic as well as its flowers being terminal mainly on main branches. The bracts are rarely up to half as long as the calyx as in *H. pallidiflora*, which is, however, distinguished by its petals being shorter than the calyx and pale yellow.

A form of *H. empetrifolia* with short and hooked simple hairs on the upper leaf surface is very similar to *H. decumbens* and also commonly grows on sandstone but usually in dry sclerophyll forest just north of Sydney. It is distinguished from the latter by its 5 or 6 stamens with short oblanceolate anthers and the base of the flowers is narrow and often stepped as is typical of that species. The similarity in these two species seems to be due to convergent evolution as the 'dichotomous' branching below flowers so common in *H. empetrifolia* is not found in *H. decumbens*.

Etymology

The epithet 'decumbens', Latin, refers to the low shrublets with usually decumbent to almost prostrate branches.

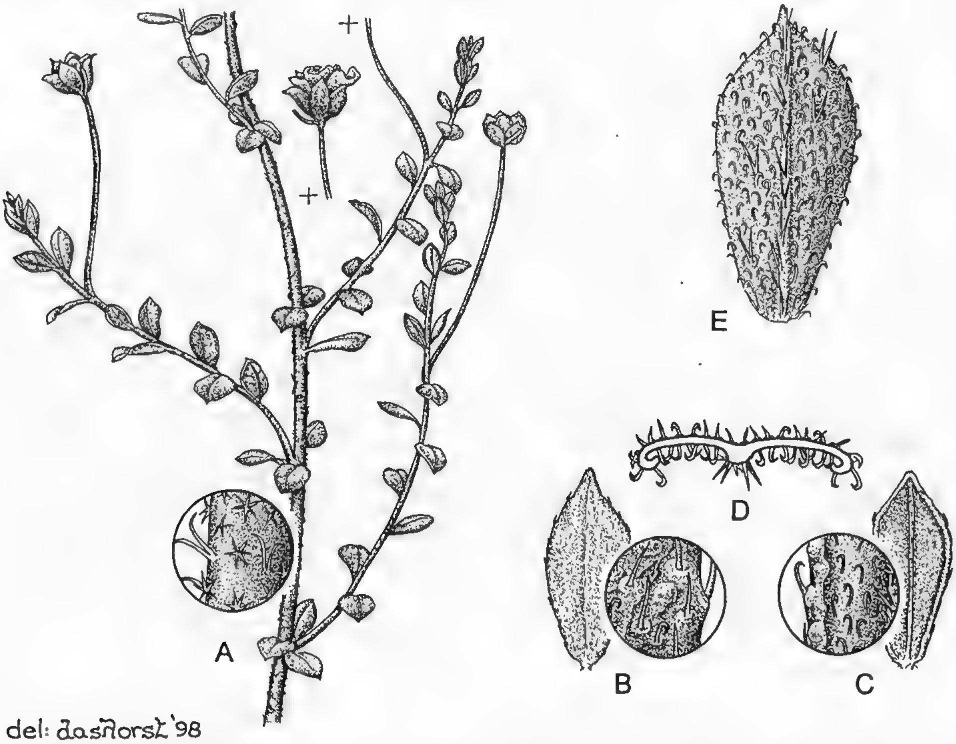

Fig. 6. *H. decumbens*. **A**, Flowering branch showing leaf-opposed flowers ×1.5; **B–D**, adult (and juvenile) leaf: **B**, above ×5; **C**, below X5; **D**, transverse section ×10; **E**, outer calyx lobe ×9. (**A–E**, *C. Burgess CBG 36200*, BRI).

Voucher specimens (14 examined)

NEW SOUTH WALES: *J.H. Maiden s.n.*, Wentworth Falls, x.1898 (NSW102231, 239376); *H.S. McKee 8985*, Woodford, 24.iii.1962 (NSW); *C.L. Wilson 493*, Castlecove, 22.iii.1957 (NSW).

H. empetrifolia (DC.) Hoogland, Kew Bull. 29: 155 (1974), partly; W.M. Curtis, Stud. Fl. Tas. edn 2: 23 (1975), partly; N.C.W. Beadle, Stud. Fl. NE New South Wales 3: 255 (1976); N.C.W. Beadle *et al.*, Vasc. Pl. Sydney edn 3: 229 (1982), partly; G.J. Harden & J. Everett in G.J. Harden, Fl. New South Wales 1: 302 (1990), partly; Toelken in N.G. Walsh & Entwisle, Fl. Vict. 3: 313 (1996), partly.

Pleurandra empetrifolia DC., Regn. Veg. Syst. Nat. 1: 420 (1817).

Type: Australia, *Herot* in Herb. Lambert (holo.: G-DC).

Shrublets with decumbent to spreading, rarely prostrate branches, up to 0.6 m high, more or less densely branched, pubescent. *Vestiture* on branches and calyx usually persisting, with antrorsely inclined, tubercled simple hairs over/rarely only the one range in size of multiangulate radial stellate hairs ((1-)2–6 branches) with small tubercle, on inside of outermost calyx lobes with few to many antrorsely appressed stellate hairs (1–3 branches); on *leaves above* often soon wearing off, like branches but stellate hairs usually very short

and/or only two rows of base cells commonly present so that it appears to have only simple hairs; on *leaves below* not persisting, few to many hooked simple hairs, except for persisting simple over stellate hairs on the flanks and central vein; of *juvenile leaves* similar to adult leaves but usually sparser and stellate hairs often with fewer branches. *Leaves* without axillary tuft of hairs; *petiole* 0–0.8 (-1.3) mm long; *lamina* narrowly oblong-elliptic, rarely oblong-oblanceolate, (2.8-) 3.6–7.5 (-16.8) × (0.6-) 1.8–3.5 (-6.4) mm, with more or less rounded apex, rarely mucronate, gradually constricted into petiole, with revolute leaf margins often covering much of the pubescent to glabrescent undersurface between them and the central vein, faintly discolourous. *Flowers* tapering or often stepped into peduncle (buds narrowly ellipsoid before opening), terminal and usually subtended by two subwhorled leaves on long and short shoots but rarely resulting in apparent dichotomous growth or more than one terminal flower on the same branch, rarely leaf-opposed; *peduncle* (1.3-) 2.4–6 (-10.4) mm long and spreading when flowering, more or less recurved when fruiting, pubescent to puberulous, with simple hairs and/or radial stellate hairs; *bracts* subtending calyx, linear-subulate, 1.3–2.4 mm long, half as long to rarely almost as long as calyx, pubescent to rarely velvety. *Calyx* often reddish-brown or sometimes pale green tinged with red to purplish; *outer lobes* ovate, 2.5–4.7 mm long, long- rarely short-acuminate, outer surface pubescent, inner surface pubesent to almost glabrous with antrorse stellate hairs each with 1–3 branches; *inner lobes* oblong to oblong-ovate, 2.9–4.1 mm long, rounded to cuspidate, usually puberulous. *Petals* narrowly obtriangular, cuneate, 3.2–6.1 mm long, bilobed, pale to bright yellow. *Stamens* (4) 5–7 (-9) in one cluster; *filaments* more or less basally connate; *anthers* obloid-obovoid, tapering towards the base, 0.6–1(-1.2) mm long, without terminal appendages, dehiscing by apical pore and introrse slits. *Pistils* 2, each with 2 basal ovules and with styles positioning the stigmas in front of the apex of the inner anthers, ovary villous to shaggy with erect stellate hairs (usually 2 branches). *Seeds* shiny brown to black, 1.5–2.1 × 2.2–2.6 mm, membranous aril with finger-like lobes covering two-thirds or more of seed.

Diagnostic features

This species is very similar to *H. appressa* (cf. discussion there), but distinguished from it by usually having some stellate hairs on both leaf surfaces and especially on the lower third of the central vein; simple hairs, if present on the lower calyx, are spreading; and stellate hairs (simple hairs in *H. appressa*) are present on developing locules, and (4-) 5–7 (-9) stamens.

H. empetrifolia, although very variable, is normally characterised by its 4–7 stamens (or locally in New South Wales CC and CS rarely up to 9) with oblong-oblanceolate anthers (0.6-) 0.8–1 (-1.15) mm long; by spreading simple hairs, if present on the lower calyx; and by normally producing only short hooked simple hairs on the undersurface of leaves except for long simple hairs over/or rarely only with very short stellate hairs with few branches on the central vein and flanks.

Variation

This variable species shows a number of local variants of which only subspecies *radians* and *uncinata* could be clearly delineated. Others may be locally distinct but show ranges of intermediates nearby so that no clear delimitation of the forms could be achieved.

In central and northern New South Wales plants often have 4 or 5 stamens and a short acumen on the outer calyx lobes, which also tend to be shorter than the inner lobes. Other plants from that area have 6–8 stamens linked with a long acumen on the outer calyx lobes, which are also longer than the inner ones, but in southern New South Wales, Victoria and Tasmania these distinctions are not maintained.

All or usually some simple hairs on plants of the typical subspecies from the Central and South Coast regions of New South Wales are sometimes hooked on specimens, and in this feature resemble subsp. *uncinata* but lack the uniform, 1–3 (-4) branched stellate hairs of that subspecies. These characters are quite independent from the fact that subsp. *uncinata* is usually found associated with sandstone rocks, while the typical subspecies is only occasionally found growing in that habitat.

The flowers of *H. empetrifolia* are normally subtended by two or three subwhorled leaves and are borne terminally on all branches, but on fast-growing branches with long internodes the lateral branches are often short and/or further reduced to almost absent with variously reduced leaves. The peduncles of the latter are often very short although relatively long ones have also been observed. Throughout the wide distribution range there seem to be some plants which have their flowers apparently arranged only in the one or other way, but because a herbarium specimen rarely shows a wide range of material from the same locality which could represent the full range of variation of that plant, one cannot evaluate at this stage whether the flower arrangement could be an important characteristic in the delimitation of some local forms.

Leaf-opposed flowers are rare and apparently associated with coppicing shoots, as they are not found on all fast-growing branches with larger leaves from the base. They are often followed by flowers with subwhorled leaves on the same branch, or at least on the same plant (e.g. subsp. *empetrifolia*: *L.G. Adams & K. Paijmans 3730* (CANB); *K. Paijmans 3975* (CANB); *A.M. Buchanan 7631* (HO); subsp. *radians*: *H.R. Toelken 8681* (AD)), but in contrast to other species they were always found without a corresponding change in the indumentum of the subtending leaves. Young plants without flowers (of the subsp. *radians* on *H.R. Toelken 9205* (AD)) have already got hairs similar to those of adult plants on their youngest leaves, including some multibranched stellate hairs, typical of this subspecies. The only difference is that these young leaves have fewer hairs and each with fewer branches. It is therefore here assumed that the juvenile indumentum is retained in this species.

For key to the subspecies see key to the species, pp. 118, 119.

subsp. **empetrifolia**.

Pleurandra empetrifolia DC., Regn. Veg. Syst. Nat. 1: 420 (1817).

H. empetrifolia (DC.) Hoogland, Kew Bull. 29: 155 (1974), partly; W.M. Curtis, Stud. Fl. Tas. edn 2: 23 (1975), partly; N.C.W. Beadle, Stud. Fl. NE New South Wales 3: 255 (1976); N.C.W. Beadle *et al.*, Vasc. Pl. Sydney edn 3: 229 (1982), partly; G.J. Harden & J. Everett in G.J. Harden, Fl. New South Wales 1: 302 (1990), partly; Toelken in N.G. Walsh & Entwisle, Fl. Vict. 3: 313 (1996), partly.

Type: as for *P. empetrifolia*.

Pleurandra ovata Labill., Nov. Holl. Pl. Specim. 2: 5 (1806), partly, as for left hand specimen of type sheet, Herb. Webb. 3936 (FI); dupl. in G (type of *P. scabra* var.*β*: see below).

P. scabra R. Br. *ex* DC., Regn. Veg. Syst. Nat. 1: 418 (1817), *non H. scabra* Benth. (1863).

Type: New South Wales, Port Jackson, *R. Brown s.n.* (holo.: G-DC; iso.: K, MEL 31453, 31490).

P. scabra R. Br. *ex* DC., var. *β* DC., Regn. Veg. Syst. Nat. 1: 419 (1817).

Type: Tasmania, *J.J.H. Labillardière s.n.*(lecto. – selected here: inscribed "P. ovata, n. Holl., m. Lambert 1816": G-DC; syn.: left specimen on sheet Herb. Webb. No. 3936: FI, photo. AD; G, see typification below, and notes of *P. ovata*: *H. appressa*).

P. astrotricha Sieber *ex* Spreng., Syst. Veg. 4, Curae Post. 191 (1827).

Type: Australia, *F.W. Sieber 149* (holo.: ?; iso.: G, K, MEL).

P. parviflora auct. non R. Br. *ex* DC.: Sieber, Fl. Nov. Holl. No. 144; Fl. Mixta No. 504.

P. ovata Labill. var. *scabra* (R. Br. *ex* DC.) Hook.f., Fl. Tas. 1: 16 (1860), partly, excl. ?specimen from Flinders Island.

Type: as for *P. scabra*.

Hibbertia billardierei F. Muell., Pl. Indig. Col. Vict.. 1: 14 (1862), partly, as for *P. scabra;* syntype: ranges beyond Snowy & Broadribb rivers, *F. Mueller MEL 31509* (cf. typification: *H. appressa*); "*Billardierii*", *nom. illeg., nom. superfl.*;.

H. billardierei F. Muell. var. *scabra* (R. Br. *ex* DC.) Benth., Fl. Austr. 1: 28 (1863), partly.

Type : as for *P. scabra.*

H. billardierei F. Muell. var. *parviflora* (R. Br. *ex* DC.) Benth., Fl. Austr. 1: 28 (1863), partly, as for *F.W. Sieber 144.*

H. billardierei F. Muell. var. *obovata auct. non* R. Br. *ex* Benth.: Benth., Fl. Austr. 1: 28 (1863), as for "Hastings river, Beckler" MEL 31477 (see also *H. hirticalyx*: typification).

H. ovata (Labill.) Druce var. *scabra* (R. Br. *ex* DC.) Domin, Biblioth. Bot. 89: 422 (1928), partly.

Type: as for *P. scabra*.

H. astrotricha (Sieber *ex* Spreng.) N.A. Wakef., Vict. Nat. 73: 167 (1957), partly, "*asterotricha*"; N.C.W. Beadle *et al.*, Vasc. Pl. Sydney edn 2: 230 (1972), partly; J.H. Willis, Handb. Pl. Vict. 2: 391 (1973), partly.

Type: as for *P. astrotricha*.

Shrublets with spreading or decumbent branches up to 0.5 m long. Vestiture of more or less spreading, usually long simple hairs over small radiating to antrorsely inclined multiangulate stellate hairs (1–5 branches) on branches, calyx and especially the upper surface of leaves where it developes a broad disc of base cells, rarely interspersed with small unicellular hooked hairs on upper leaf surface and calyx. *Flowers*: (Aug.) Sept.–Feb. (March) and occasional records throughout the year. Fig. 7A–F.

Distribution and ecology

Growing usually as a ground cover or scrambling over other vegetation in woodland or sclerophyll forest in New South Wales (NC, CC, CT, SC, ST), Victoria (EG, GPL, PROM) and Tasmania.

Conservation status: Common and widespread species.

Diagnostic features

Since the long simple hairs particularly on the branches often soon wear off or are in some forms smaller, it was found useful to distinguish this subspecies by the absence of broad-tubercled radiating stellate hairs on the abaxial petiole and/or along the central vein as is usually found in the subsp. *radians*, which occurs only in South Australia.

Variation (see under species)

Typification

The only sheet in Herb. DC. inscribed "***P.[leurandra] scabra β***" contains two specimens:

1. a fragment of "*Pl. astrotricha* Sieber in herb. DC. 20"

2. two twigs labelled "P. ovata? – n. Holl. – m. Lambert 1816"

Since there was some doubt as to the identification of *P. ovata* it seems likely that the latter specimen is a fragment from Labillardière's collection of *P. ovata* although it is not actually stated but agrees with the other specimen (left specimen of *P. ovata*, Herb. Webb. No 3936) of that collection examined. Since this is according to all evidence the only specimen that seems to have been seen by de Candolle (1817), it was selected as lectotype of his *P. scabra* var. *β* (see also *H. appressa*: typification).

The holotype of ***Pleurandra astrotricha*** could not be located as Sprengel's herbarium was sold in many different parts (Stafleu & Cowan 1985), but as it is not known to have been destroyed, no neotype was selected from the two isotypes examined.

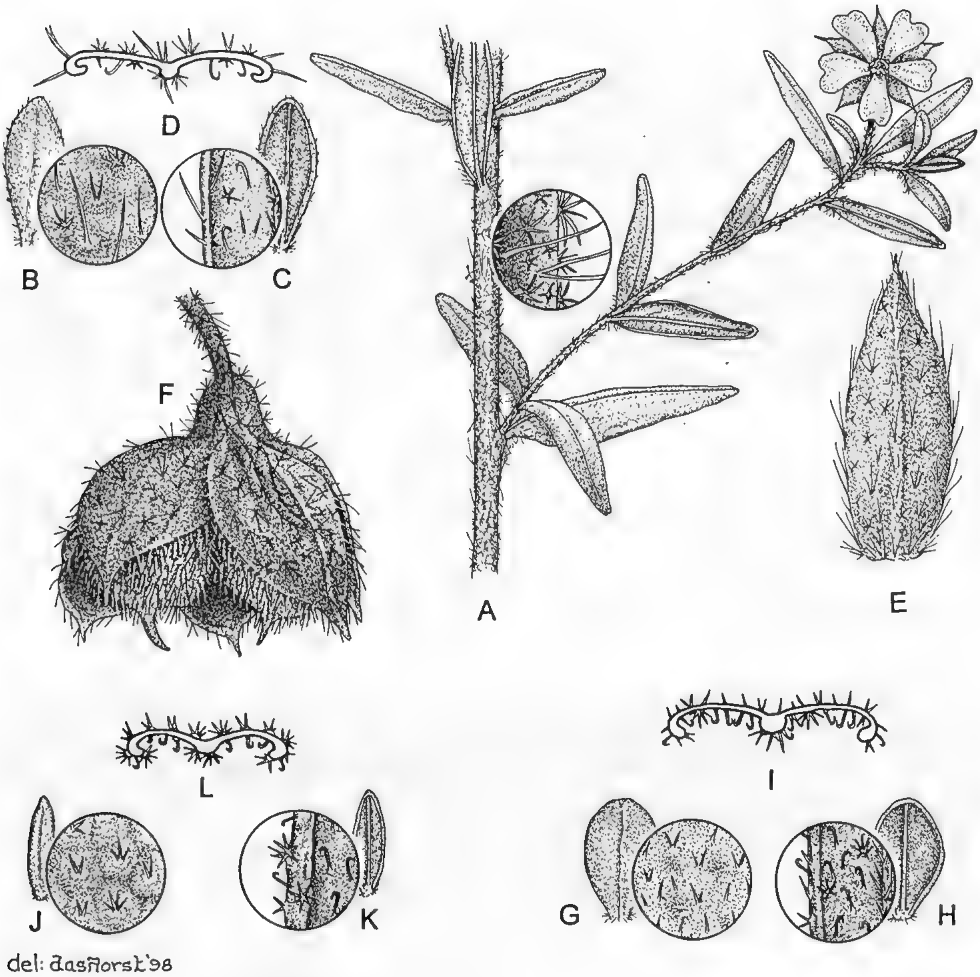

Fig. 7. *H. empetrifolia* subsp. ***empetrifolia***. **A**, Flowering branch with two subwhorled leaves below flower ×3; **B–D**, adult leaf: **B**, above ×3; **C**, below ×3; **D**, transverse section ×12; **E**, outer calyx lobe ×10; **F**, fruit with stellate hairs with two branches on the follicles ×8. –subsp. ***uncinata***. **G–I**, adult leaf: **G**, above ×3; **H**, below ×3; **I**, transverse section ×9. –subsp. ***radians***. **J–L**, adult leaf: **J**, above ×3; **K**, below ×3; **L**, transverse section ×15. (**A–E**, *J. Pulley CBG 44234*, CANB; **F**, *H.R. Toelken 9253*, AD; **G–I**, *W.F. Blakeley CANB 220908*; **J–L**, *D.N. Kraehenbuehl 211*, AD).

Voucher specimens (292 examined)

NEW SOUTH WALES: *R.D. Hoogland 11779*, near Arakoon, 9.x.1970 (CANB, K, MEL, NSW); *R.D. Hoogland 12465*, "The Elbow" on Georges River, c. 2.5 km SE Campelltown, 7.x.1974 (CANB, HBG, L, NSW, UC); *R. Pullen 4123*, c. 1.5 mls NW Mt Budawang, 6.xii.1965 (A, AD, BH, BRI, K, L, MEL, NSW); *M.J. Taylor 323 & R.G. Coveny*, Govetts Leap, Blackheath, 23.x.1984 (CANB. MEL, NSW, PERTH).

VICTORIA: *J.W. Audas & P.R.H. St John MEL 31512*, Tidal River, Wilsons Promontory, 14.xi.1908 (MEL); *A.C. Beauglehole 50272*, 21.5 km SSE Gormandale P.O., 2.x.1975 (CANB, MEL, NSW); *J.H. Ross 3499*, 5 km NW Mallacoota, 21.x.1991 (AD, CANB, BRI, HO, MEL, NSW, RSA, S);

TASMANIA: *A. Moscal 2470*, St Marys Pass State Reserve, 2.vi.1983 (AD, HO, MEL); *A. Moscal 2670*, Reeves Creek, Picnic Rocks, 13.ix.1983 (AD, AK, HO, MEL); *M.E. Phillips CBG 24005*, near St Helens, 16.xi.1960 (CANB, NSW).

Putative hybrid

H. aspera subsp. *aspera* × *H. empetrifolia* subsp. *empetrifolia* see *H. aspera* subsp. *aspera.*

subsp. **uncinata** Toelken, *subsp. nov.*

A subspeciebus aliis combinatione pilorum stellatorum 1–3 (4) ramis in pedunculis ramisque et pilorum uncinatorum in foliis adaxilaribus calicibusque differt.

Type: New South Wales, 4 mls SW Mangrove Mountain, *R.D. Hoogland 12243* (holo.: sheet 2, CANB 226041; iso.: sheet 1, CANB 226040, K *n.v.*, L. *n.v.*, NSW).

Shrublets with spreading to decumbent branches rarely more than 0.6 m long. *Vestiture* of branches and peduncle more or less spreading simple hairs over/or fine radiating to erect multiangulate stellate hairs (1–3 (4) branches); on upper leaf surface and outer calyx lobes sometimes with spreading simple hairs over/and usually antrorsely inclined multiangulate stellate hairs (1–3 branches) and/or more or less hooked simple hairs. *Flowers*: Sept.–April, variable. Fig. 7G–I.

Distribution and ecology

Usually growing on sandstone varying from drier to moist habitats in sclerophyll woodland north of Sydney (CC).

Conservation status: there are no recent collections available to assess present status.

Diagnostic features

Distinguished from the other two subspecies by the combination of hooked simple hairs on adaxial leaf surfaces as well as calyx lobes, and stellate hairs with 1–3(4) branches ((4) 5–12 branches in other subspecies) on the branches, peduncle and outer calyx lobes, and the hooked hairs throughout the whole or towards the flanks of the upper surface. The stellate hairs on the central vein are usually frequent, which is not commonly found in the species, and these hairs have four or more branches.

Unlike the very similar *H. decumbens* this subspecies usually has 5 or 6 stamens with short oblong-oblanceolate anthers, and the base of the flower is narrow and usually stepped (see also notes below).

Variation

It is sometimes difficult to recognise this subspecies because in section along the same branch the hairs become so dense that one can only discern the characteristic few branches on each stellate hair with difficulty. Since the hooked hairs on the upper surfaces of leaves also wear off in some plants more quickly than in others they are often only visible on the flanks. This feature is occasionally also found on leaves of plants of local forms of the other subspecies. It is therefore important to check in the identification of this subspecies the combination of the above two characteristics.

While a range of simple hairs and/or stellate hairs can be observed on the undersurface, this is usually associated with a change on every new branch from only hooked simple hairs to more or less stellate hairs (ultimately with up to 6 branches) along the central vein and occasionally also along the secondary veins. On some branches this change is rapid while on others of the same plant it does not complete the range. Since it is unknown what induces

this variation it cannot be evaluated from herbarium material whether incomplete ranges shown by some specimens should be attributed to a genetical or ecological basis.

Notes

This taxon is insufficiently understood. As the above diagnostic features indicate this taxon is very close to *H. decumbens*. It is included within *H. empetrifolia* because of its similar stamens and its similar acuminate calyx lobes as well as the fact that all the flowers investigated were produced from two or three subwhorled leaves. Hooked simple hairs are also found on the upper leaf surface and on the calyx of some plants of subsp. *empetrifolia* from the adjoining botanical divisions of Central and Southern Coast, but they are then usually sparse and not combined with the few branches of the stellate hairs on branches and the peduncle. Throughout the range of the typical subspecies there are also odd local forms which have stellate hairs with few branches on the branches and peduncle but they do not produce hooked simple hairs on the upper leaf surface. The hooked hairs on the upper leaf surface as well as the development of stellate hairs with sometimes a larger number of branches are reminiscent of subsp. *radians* (endemic in South Australia).

Etymology

The epithet 'uncinata', Latin, 'hooked' refers to the common hooked simple hairs on the leaves and calyx, which together with the little-branched stellate hairs on the branches and peduncle are a characteristic feature of this taxon.

Voucher specimens (14 examined)

NEW SOUTH WALES: *E.F. Constable NSW 45582*, Kariony, Upper Woy Woy Road, 17.ii.1958 (NSW); *L.A.S. Johnson NSW 102262*, c. 3 mls S Sampsons Pass, c. 7 mls w Kulnura, 17.x.1965 (NSW); *C.T. White 10262*, Kulnura, 5.xii.1935 (BRI).

subsp. **radians** Toelken, *subsp. nov.*

H. billardierei auctt. non F. Muell.: Tate, Trans. Proc. Rep. Roy. Soc. S. Australia 6: 149 (1883), "*Billardieri*"; Trans. Proc. Rep. Roy. Soc. S. Australia 12: 65 (1889), "*Billardieri*"; Handb. Fl. S. Australia pp. 14, 205 (1890), "*Billardieri*", partly.

H. billardierei F. Muell. var. *parviflora* auct. non (R. Br. *ex* DC.) Benth.: J.M. Black, Fl. S. Austr. edn 2, 3: 576 (1952).

H. aspera auctt. non DC.: H. Eichler, Suppl. Fl. S. Austr. 227 (1965); Jessop in Jessop & Toelken, Fl. S. Austr. edn 4, 1: 355 (1986), partly.

H. sp. B. Toelken in Jessop, List Vasc. Pl. S. Austr. edn 4, 28 (1993).

A subsp. *empetrifoliae* presentia pilorum stellatorum (inter pilos alios) basis latis ramisque multis (6–14) praecipue in vena centrali petioloque infra folios differt.

Type: South Australia, 4 km SSW Parawa, *H.R. Toelken 8681*, 28.ix.1997 (holo.: AD; iso.: K, MO, NSW, PERTH).

Shrublets with prostrate, rarely decumbent slightly woody branches to 35 cm long. *Vestiture* of more or less larger broad-tubercled multiangulate radiating stellate hairs (6–14 branches) between/over smaller antrorse or erect stellate hairs (1–4 branches) on branches, upper leaf surface, the lower petiole, the lower central vein and calyx all with a broad disc of base cells, sometimes interspersed with very small unicellular hooked hairs without tubercle base on upper leaf surface and calyx. Long simple hairs on branches and calyx (or only a few on the terminal beak of outer calyx lobes) are absent. *Flowers*: mainly Aug.–Dec. Figs. 2E; 7J–L.

Distribution and ecology

Growing usually on shallow lateritic soil often with ironstone, rarely recorded from sandy or swampy soils, and locally common in woodland or mallee but also often in scrub or disturbed vegetation; restricted to South Australia (SL, KI).

Conservation status: Although it has a restricted distribution it is locally common and represented in several conservation parks.

Diagnostic features

Although the broad-tubercled stellate hairs were found on all specimens examined they are sometimes not common so that it was found useful to search for them on the lower petiole and central vein. Simple hooked hairs on the upper leaf surface as found in subsp. *radians* are occasionally also found on specimens of subsp. *empetrifolia* north of Sydney, but the latter do not have broad-tubercled stellate hairs as found in subsp. *radians*.

Variation: Juvenile and ecological forms as recorded for the species.

Etymology

The epithet 'radians', Latin, 'radiating' refers to the characteristic broad-tubercled radiating stellate hairs on leaves of this subspecies.

Notes

The subsp. *radians* is restricted to lateritic soils. It is geographically isolated from typical *H. empetrifolia*, which extends to south-east Victoria. This subspecies is more than just one of the many local forms of this species.

The first specimens of this taxon were collected by Tate on Kangaroo Island in 1881 (*R. Tate AD 97620417* – see Tate 1883) and 1883 (*R. Tate AD 97620414*) followed by several of J.G.O. Tepper (MEL, AD) in 1886/7, but they were all identified as *H. billardierei* without further reference to a variety as distinguished by Bentham (1863).

The petals of plants examined in the field often remained erect and more or less tubular as in *H. pallidiflora* for several hours in the morning before they recurve to the fully open, rotate flowers commonly found in *Hibbertia* species.

Voucher specimens (76 examined)

SOUTH AUSTRALIA: *M. Fagg 783*, Deep Creek, 16.viii.1970 (AD, CANB, L); *P. Martensz 325*, roadside, Kangaroo Island, 3.x.1970 (AD, CANB, K, L, MEL); *R. Schodde 1136*, Deep Creek, 29.viii. 1959 (AD, CANB).

H. hirta Toelken, *sp. nov.*

H. hirticalyci et *H. rhynchocalyci* similis 10–12 staminibus antheris linearibus et 1.3–1.5 mm longis sed foliis tectis apprime subtus praecipue pilis simplicibus differt.

Type: New South Wales, Budawang Range, *J. Pulley & I. Telford BR 204*, 5.x.1971 (holo.: CANB; iso.: MEL, NSW).

Shrubs up to 0.5 m high, with ±rigid erect branches, villous. *Vestiture* on branches and calyx persisting, with few long antrorsely curved simple hairs with pronounced tubercle over/grading into a wide range of sizes of erect radial stellate hairs (1–5 similar or unequal branches) with pronounced tubercle but apparently no base cells; on *leaves above* persisting, with mainly long simple hairs with a ring of a few raised base cells forming pronounced tubercled bases, over often few shorter erect radial stellate hairs (1–3 similar or unequal branches) similar to those on branches; on *leaves below* persisting, as above but

finer (especially the tubercles except for similarly coarse hairs on the flanks and the central vein and which often overtop the others); *juvenile leaves* (insufficiently known cf. variation below) with straight simple hairs, which are finer on both surfaces but particularly so on the undersurface. *Leaves* without axillary tuft of hairs; *petiole* 0.6–1.2 mm long; *lamina* linear-oblanceolate rarely-elliptic, (6-) 7.5–10 (-13.8) × 1.3–2.2 (-2.6) mm, obtuse to rounded, rarely acute when young, gradually tapering into petiole, villous above and below, pale green?; margins revolute but undersurface exposed between them and the more or less raised central vein. *Flowers* abruptly constricted into peduncle (buds obovoid before opening), terminal on all branches (apparently without short shoots) subtended by (3) 4 (5) subwhorled leaves but usually only one axis continues growth, not leaf-opposed along branches; *peduncle* (2.7-) 3.5–6 (-8.4) mm long and spreading when flowering, recurved when fruiting, stellate-villous; *bract* subtending calyx, linear-subulate, 4.2–6.3 mm, usually two-thirds to almost as long as the calyx, stellate-villous. *Calyx* green: *outer lobes* lanceolate to ovate, 6.1–6.5 mm long, long-acuminate (acumen often almost as long as lanceolate base), outer surface villous, inner surface with scattered long antrorse simple hairs; *inner lobes* oblong-ovate, 5.8–6.1, acuminate to mucronate, villous to pubescent. *Petals* broadly obovate, 4.1–5.6 mm long, truncate and emarginate to more or less bilobed, papillose mainly towards the centre, yellow. *Stamens* 11, 12 in one cluster; *filaments* basally connate; *anthers* narrowly obloid, 1.3–1.5 mm long, without terminal appendages, dehiscing mainly by introrse slits. *Pistils* 2, each with 2 ventral ovules and with short terminal styles positioning the stigmas near the apex of the central anthers, ovary villous, with erect mainly stellate hairs. *Seeds* not seen. *Flowers*: Mainly Oct., but also one record in mid-June. Fig. 8A–H.

Distribution and ecology

Grows in association with sandstone or conglomerate cliffs on the Budawang Range, New South Wales (SC).

Conservation status: Known only from a very restricted area in Morton National Park.

Diagnostic features

The long spreading, mainly simple hairs on the leaves and calyx, long bracts and 10–12 linear anthers suggests a similarity with *H. hirticalyx* and *H. rhynchocalyx*, but in constrast to those species *H. hirta* has long simple hairs on the undersurface of the narrow leaves. The base cells of the erect hairs on the upper leaf surface are characteristically raised, so that they look like goosebumps on human skin.

Variation

The indumentum of the leaves shows considerable variation in the density of the hairs and the relative numbers of simple and stellate hairs. Leaves with mainly straight simple hairs on their undersurfaces do occur usually towards the base of branches (e.g. *J. Pulley CBG 44273*). The fact that this plant was not flowering as compared with the second specimen collected that day (*J. Pulley CBG 44272*) could indicate that it is young but not quite juvenile any more, because it has already quite woody branches. Until a wider range of material and especially coppicing or known juvenile material can be examined, leaves with straight simple hairs on their undersurface are interpreted as an intermediate stage between juvenile and adult leaves, as it is possible that extreme juvenile leaves do show the commonly found hooked simple hairs. In fig. 8E this variation is recorded.

Etymology

The epithet 'hirta', Latin, villous refers to the fine spreading hairs covering most parts of the plant.

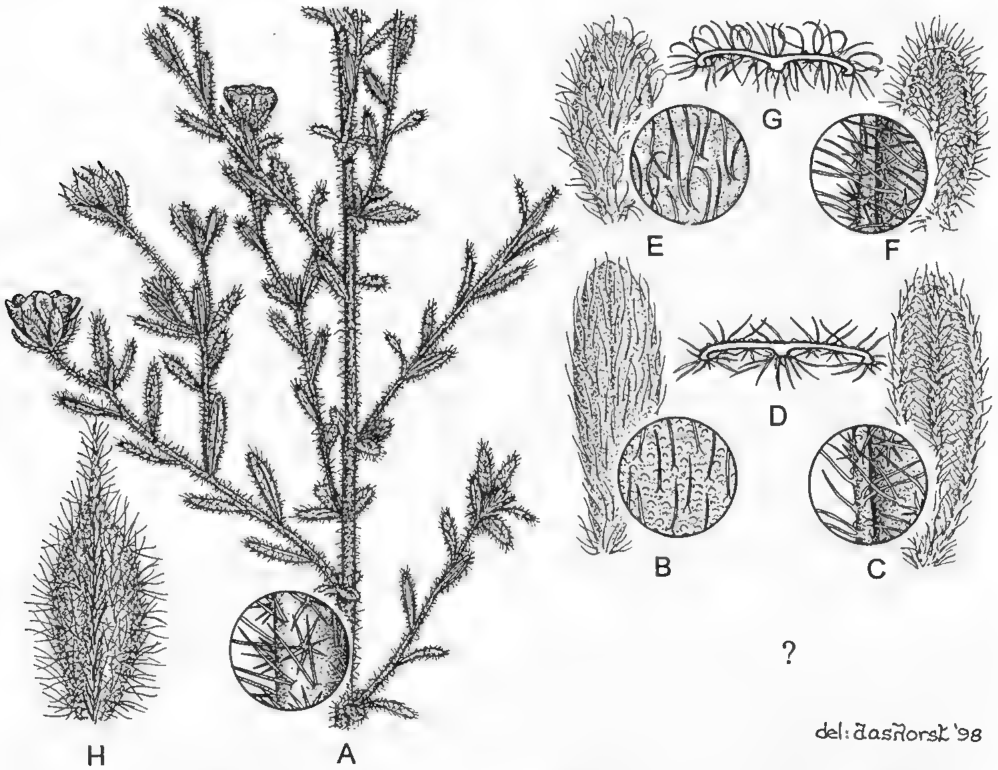

Fig. 8. ***H. hirta***. **A**, Flowering branch ×1.5; **B–D**, adult leaf: **B**, above 4; **C**, below × 4; **D**, transverse section ×8; **E–G**, ?intermediate stage leaf: **E**, above ×4; **F**, below ×4; **G**, transverse section ×8; **?** = juvenile leaf unknown; **H**, outer calyx lobe ×9. (**A–D**, **H**, *J. Pulley CBG 44272*, CANB; **E–G**, *J. Pulley CBG 44273*, CANB).

Voucher specimens (8 examined)

NEW SOUTH WALES: Budawang Range: *P. Gilmour 5275*, 3.x.1985 (CANB); *J. Pulley BR 62*, 17.vi.1971 (CANB); *T. & S. Whaite 3110*, 2.x.1966 (NSW).

H. hirticalyx Toelken, *sp. nov.*

Pleurandra astrotricha auct. non Sieb. *ex* Spreng.: Hook., J. Bot. (Hook.) 2: 402 (1840), as for *R.C. Gunn 893/1837*, Flinders Island, 26.i.1838.

P. ovata var. *scabra* Hook.f., Fl. Tasmania 16 (1855), partly as for *R.C. Gunn 893*.

H. billardierei F. Muell., Pl. Indig. Col. Vict. 1: 14 (1862), partly, as for syntype: near Sealers Cove & on Mount Hunter, *F. Mueller MEL 31499* (cf. typification: *H. appressa*), "*Billardierii*", *nom. illeg., nom. superfl.*

H. billardierei F. Muell. var. *monadelpha* F. Muell. *ex* Benth., Fl. Austr. 1: 28 (1863); F. Muell., Fragm. 4: 116 (1864); Rodway, Tasm. Fl. 4 (1903); W.M. Curtis, Stud. Fl. Tasm. edn 1, 1: 22 (1956).

Type: Victoria, mountains near Sealers Cove, *F. Mueller MEL 31499*, v.1853 (lecto. – selected here: MEL; iso.: AD; syn.: Tasmania, Flinders Island, *R.C. Gunn [893/1837]*, K, NSW 112231 – cf. typification below).

H. billardierei var. *obovata* R. Br. *ex* Benth., Fl. Austr. 1: 28 (1863).

Type: Tasmania, Port Dalrymple, *R. Brown s. n.* (lecto. – selected here: BM (left specimen); iso.: BM (right specimen), K; syn.: Hastings River, *Beckler MEL 31567* (see *H. aspera* subsp. aff. *aspera*); *Beckler MEL 31477* (see *H. empetrifolia* subsp. *empetrifolia*); ?West Head, *R.C. Gunn [893] n.v.*– cf. typification below).

H. ovata (Labill.) Druce var. *monadelpha* (F. Muell. *ex* Benth.) Domin, Biblioth. Bot. 89: 422 (1928); Ewart, Fl. Vict. 769 (1931).

Type: as for *H. billardierei* var. *monadelpha*.

H. ovata (Labill.) Druce var. *obovata* (R. Br. *ex* Benth.) Domin, Biblioth. Bot. 89: 422(1928).

Type: as for *H. billardierei* var. *obovata*.

H. aspera auctt. non DC.: N.A. Wakef., Vict. Nat. 73: 167 (1957), partly; J.R. Garnet, Wildflow. Wilsons Prom. 152, t. 577 (1971), partly; J.H. Willis, Pl. Vict. 2: 391 (1973), partly; Hoogland, Kew Bull. 29: 155 (1974); W.M. Curtis, Stud. Fl. Tas. 1, edn 2: 23 (1975); Toelken in N.G. Walsh & Entwisle, Fl. Vict. : 312 (1996), partly.

H. cinereae similis sed foliis plus minusve tectis pilis simplicibus et calycis lobis exterioribus costatis rostratisque differt; a *H. aspera* 10–15 staminibus et foliorum paginis abaxialibus glabrescentibus differt.

Type: Tasmania, Tamar Creek, 2 km NE Gladstone, *A.E. Orchard 5860*, 7.xi.1983 (holo.: HO; iso.: AD, AK, CANB, MEL).

Shrubs with erect, spreading or decumbent branches, 0.3–1 (–3) m tall, usually densely branched, pubescent. *Vestiture* on branches persisting, with long antrorse simple hairs, each with a small tubercle, over larger and smaller erect, rarely multiangulate radial stellate hairs with 3–5 similar/unequal branches; on calyx with long spreading tubercle-based simple hairs over short usually multiangulate antrorse/radial tubercle-based stellate hairs (usually 2,3 unequal, or 3–6 similar branches); *on leaves above* wearing off but base cells remain prominent, with long, rarely short simple hairs with pronounced base cells sometimes tuberculate, over short multiangulate radial (3–6 similar branches) and/or antrorse (1–3 often unequal branches) stellate hairs; *on leaves below* persisting, with few scattered simple hairs on the flanks and central vein over multiangulate/depressed radial stellate hairs (5–12 similar, rarely unequal branches) rarely overlapping, with distinct tubercles, sometimes some stellate hairs overtopping others; *on juvenile leaves* below with short hooked simple hairs replaced progressively by multiangulate stellate hairs. *Leaves* without axillary tuft of hairs; *petiole* 0.4–1.4 mm long; *lamina* elliptic-oblanceolate, elliptic, rarely elliptic-obovate, (5.6-) 8–17 (-25.6) × 2–8 (-10.2) mm, obtuse to rounded, rarely truncate, often mucronate with central vein more or less protrudinging, with cuneate base, above pubescent to glabrescent, below puberulous to glabrescent when juvenile, pubescent or rarely tomentose on adult leaves, ±discolourous; margins recurved to revolute and undersurface more or less exposed between them and the slightly raised central vein. *Flowers* abruptly constricted but with stepped base when fruiting into the peduncle (buds oblong-obovoid before opening), terminal on all branches and sometimes on short shoots (including ones with reduced leaves), subtended by 2 (3) subwhorled leaves rarely leading to dichotomous growth, rarely leaf-opposed along main branches (then no flowers in succession observed); *peduncle* 1.8–8 mm long or up to 14 mm when fruiting, with scattered spreading simple hairs over stellate-pubescence; *bracts* subtending calyx, linear-subulate, 3–4.4 mm long, usually two-thirds to as long as calyx, few spreading simple hairs over stellate-pubescence. *Calyx* pale green sometimes tinged purple: *outer lobes* lanceolate, 3.2–6.3 mm long, usually long-acuminate, outer surface with scattered long spreading simple hairs over stellate-pubescent, inner surface with scattered fine antrorse stellate hairs with usually 2, 3 branches; *inner lobes* oblong-ovate, 3.2–6.2 mm long, acuminate or obtuse and mucronate, pubescent to puberulous and rarely only with stellate hairs. *Petals* broad-cuneate, rarely cuneate-spathulate, 6–9.6 mm long, usually bilobed, bright yellow. *Stamens* (7) 8–12 in one cluster; filament usually at least half connate; *anthers* narrowly obloid, (1.1-) 1.2–1.7 mm long, with central ones often with short appendage or acute, dehiscing mainly by lateral slits. *Pistils* 2; each with (2-) 4 ventral ovules and with style positioning stigmas below the apex of the central anthers, and ovary shaggy with erect stellate hairs. *Seeds* brown to shiny-black, 1.8–

2 × 2 mm, up to two-thirds covered with lobed membranous aril. *Flowers*: Sept.–Nov. Fig. 9A–K.

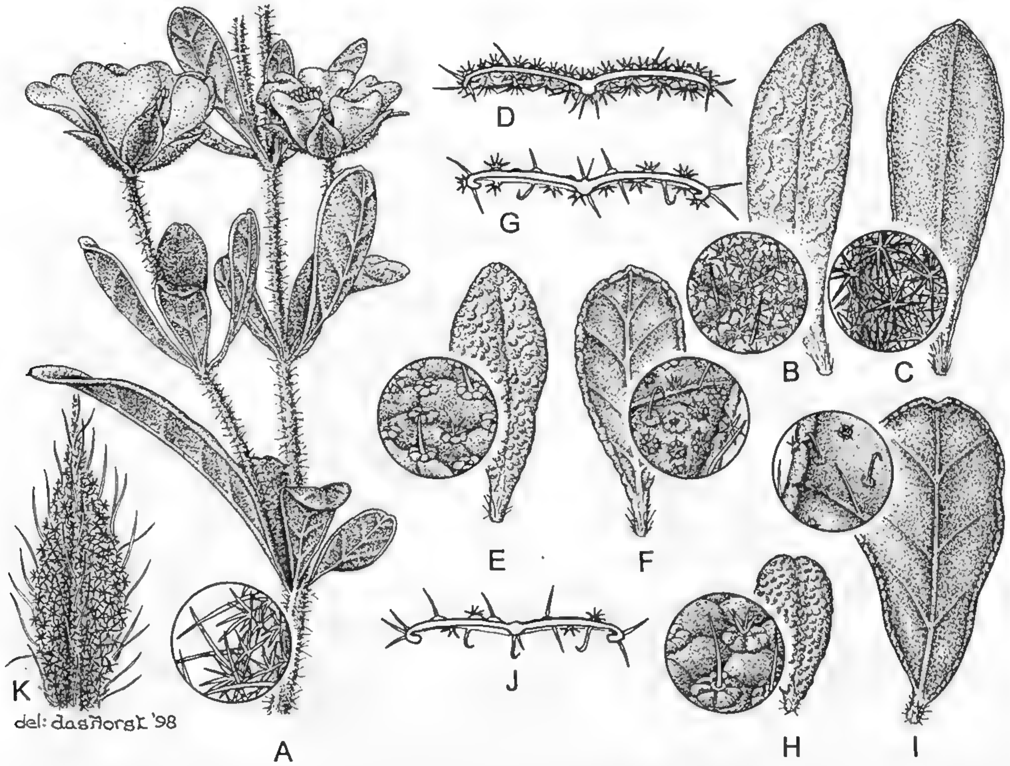

Fig. 9. ***H. hirticalyx***. **A**, Flowering branch with terminal flowers on branches and short shoots ×2; **B–D**, adult leaf: **B**, above ×3; **C**, below ×3; transverse section ×6; **E–G**, intermediate stage leaf: **E**, above ×3; **F**, below ×3; **G**, transverse section ×6; **H–J**, juvenile leaf: **H**, above ×3; **I**, below ×3; **J**, transverse section ×6; **K**, outer calyx lobe ×8. (**A–D**, **K**, *J.W. Audas & P.R.H. St John MEL 649413*; *A. Moscal 2531*, HO).

Distribution and ecology

Growing in sandy soil usually associated with granite, on wet seepage areas on Wilsons Promontory in Victoria (PROM) as well as northern Tasmania including some of the islands in the Bass Strait.

Conservation status: Locally common and conserved in parks.

Diagnostic features

This species is mainly distinguished from the very similar *H. cinerea* by its spreading simple hairs over a more or less uniform tomentum of stellate hairs, which give particularly the calyx but also the petiole and the central vein of leaves a hairy appearance. The distinctly ridged outer three calyx lobes are terminated in a long beak up to one-third of their length while these are very short in *H. cinerea*. The latter species is usually associated with limestone whereas *H. hirticalyx* shows a preference for acid soils.

Variation

Being an extremely variable species, much more material is needed to understand the variation, particularly the vestiture shown on plants within often widely separated populations. Specimens from Wilsons Promontory are much more hairy (denser and with often longer simple hairs) than most of the Tasmanian collections seen. No juvenile form with only few hooked hairs on the undersurface of the leaves has been observed from Victorian collections as has commonly been recorded in Tasmanian material. The stellate hairs on the upper surface of the leaves of the former also tend to be small and with 4–6 radiating branches while those from Tasmania are larger and with 2,3 (4) antrorse branches. Some leaves have only simple hairs above but they grade into others with antrorse stellate hairs (*A. Moscal 2531*). The significance of the two types of stellate hairs sometimes on different leaves and sometimes on the same but with widely varying distribution patterns on leaves from apparently different populations, can at present only be tentatively explained as developmental stages, and are probably determined by local genetic and/or ecological factors. Until the full range of variation from juvenile to adult leaves and/or ecological variation is recorded for many of the different populations the phenomenon cannot be evaluated adequately. It seems that, for instance, shading is an important factor as the more glabrous plants and those with simple hairs are often described as understorey plants. In *H. pallidiflora* shading seems to contribute towards the retention of juvenile characteristics, or hold development at an intermediate stage between the extremes.

Leaf-opposed flowers in this species are also associated with juvenile leaves on Tasmanian plants and at times they grade into the stage with usually two subwhorled leaves subtending the peduncle. However, unlike intermediate stages in *H. pallidiflora* the base of the peduncle is always associated with one or more leaves. On Tasmanian plants, flowers are usually borne terminally on all branches while most of the flowers on Victorian plants are produced on short shoots often with reduced leaves.

The habit is also described from Wilsons Promontary and Flinders Island as shrubs up to 3 m tall, while in at least one record from Tasmania is described as a “dominant ground cover”.

Typification

Bentham’s protologue of ***H. billardierei*** var. ***obovata*** states: ‘Leaves and flowers of *a* [var. *monadelpha*], but ovules only 2’ and then quotes three collections. The first of these ‘*Pleurandra obovata*, R. Br. Herb., from Port Dalrymple’ (now identified as *H. hirticalyx*) shows that Bentham had consulted the R. Brown collection as there is an annotation (“Hibbertia Billardieri F. Muell. var. obovata (cf. ovules 2 only)”) on the sheet in the BM. There are two branches on this herbarium sheet but it cannot be ascertained whether Bentham’s comment applies to the left specimen below which the comment is now mounted or refers to the whole collection before duplicates were sent out (cf. W.T. Stearn (1960), pp. xxvi-xxviii of Introduction to facsimile edition of R. Brown’s Prodromus). There is no description of this species in Brown’s manuscript (microfilm :AD). The name is only mentioned in the index to *Pleurandra* but with a note ‘4 sp[ermae]’ unlike the two ovules mentioned by Bentham. The R. Brown specimen at K was only presented to this herbarium in 1880, so that Bentham could not have consulted it.

Two collections of the second specimen quoted and initialled by Bentham ‘Hastings river, *Beckler*’ were also found to be compatible with the brief protologue. MEL 31567 is now identified as *H. aspera* subsp. aff. *aspera* and MEL 31477 as *H. empetrifolia* subsp. *empetrifolia.*

The third specimen referred to by Bentham ‘West Head, Tasmania, *Gunn [893]*’ is also likely to have been one of *H. hirticalyx*. However, no specimen of this collection annotated

by Bentham could be traced in K or MEL, although several specimens with that 'species number' but from other localities or from later dates exist.

Since the R. Brown collection explains the choice of the epithet and the sheet in BM bears an annotation by Bentham stating the name and diagnostic feature, the left specimens, being similar to the right one, was chosen as the lectotype.

The specimen *F. Mueller MEL 31499* from Sealers Cove was selected as the lectotype of ***H. billardierei*** var. ***monadelpha*** as it is annotated in Mueller's hand as *Pleurandra monadelpha* and Bentham annotated it as "Hibbertia Billardieri α monadelpha" in contrast to the second collection quoted by Bentham but not annotated by him, *Gunn 893* from Flinders Island (K, with details of several collections of this species). Since the two collections are similar the former was preferred.

Etymology

The epithet 'hirticalyx', Latin (but 'calyx' originally from Greek), 'calyx with long distinct hairs', referring to the long soft simple hairs over stellate hairs covering the calyx.

Voucher specimens (61 examined)

VICTORIA: *R.D. Hoogland 11904*, Mount Oberon, 25.xi.1970 (CANB, MEL, K).

TASMANIA: *R.C. Gunn 893*, West Head, Georgetown, 21.x.1844 (NSW 102163); *A. Moscal 2693*, Reeves Creek-Picnic Corner, 14.ix.1983 (AD, HO, MEL); *J.S. Whinray 2452*, Mount Killiecrankie, Flinders Island, 1.x.1978 (HO).

H. notabilis Toelken, *sp. nov.*

H. asperae persimilis sed 10–12 antheris quoque 1–1.4 mm longis, foliorum paginis adaxialibus praecipue pilis simplicibus; *H. hirticalyci* bracteis brevibus, calycis loborum extimorum rostratis brevissimis, foliorum paginis abaxialibus dense velutinis differt.

Type: New South Wales, Nadgee Nature Reserve, *D.E. Albrecht 1037*, 28.ix.1984 (holo.: MEL 673624).

Shrubs up to 0.8 m tall, more or less densely branched, densely pubescent to villous. *Vestiture* on branches persisting, with long antrorsely curved simple hairs with small tubercle over larger and smaller erect or rarely multiangulate radial stellate hairs with 3–6 similar/unequal branches; on calyx with long spreading tubercle-based simple hairs over short multiangulate radial, rarely antrorse tubercle-based stellate hairs (usually 3–5 similar, rarely unequal branches); *on leaves above* wearing off except for base cells remaining prominent, with short simple hairs with pronounced base cells sometimes tuberculate over/grading into erect, usually antrorse stellate hairs (1–4 ± similar branches) often restricted to the base, the central groove and the flanks; *on leaves below* persisting, with few scattered simple hairs on the flanks and on the central vein over multiangulate radial stellate hairs (5–13 similar, rarely unequal branches densely overlapping and with small tubercles; *juvenile leaves* not seen. *Leaves* without axillary tuft of hairs; *petiole* 0.3–0.8 mm long; *lamina* obovate to oblanceolate, rarely elliptic-oblanceolate, 4.1–9.2 × 1.4–4.8 mm, truncate and ± emarginate, rarely rounded, with cuneate base, above pubescent to glabrescent, below villous to velutinous, discolourous; margins ± revolute and undersurface well exposed between them and the scarcely raised central vein. *Flowers* abruptly constricted into peduncle (buds broadly oblong-obovoid before opening), terminal on all branches and often on short shoots, usually subtended by 3 subwhorled leaves leading to dichotomous or trichotomous branching but often immediately ending again in flowers, leaf-opposed flowers not seen; *peduncle* 2.5–6.1 mm long and up to 9.2 mm when fruiting, villous to pubescent like branches; *bracts* subtending calyx, linear-subulate, 1.6–2.1 mm long, usually less than half as long as the calyx, villous like pedicel. *Calyx* pale green; *outer lobes* lanceolate to ovate, 4.1–4.3 mm long, shortly acuminate to acute, outer surface with

scattered long simple hairs mainly along the pronounced central ridge and the flanks over multiangulate radial stellate hairs with 4–8 often unequal branches, inner surface antrorse stellate-puberulous towards the apex; *inner lobes* oblong-ovate, 4.2–4.5 mm long, rounded, rarely acute, puberulous and often with stellate hairs only. *Petals* broadly obovate-cuneate, 5–8.6 mm long, distinctly bilobed, papillose, yellow. *Stamens* 10–12 in one cluster; *filaments* usually about half connate; *anthers* narrowly obloid, 1–1.4 mm long, with short blunt appendages (almost rounded), dehiscing mainly by lateral slit. *Pistils* 2, each with 4 almost basal ovules and with style positioning stigmas below the apex of the anthers, and ovary short-shaggy with erect stellate hairs. *Seeds* not seen. *Flowers*: Sept.–Oct. Fig. 10A–E.

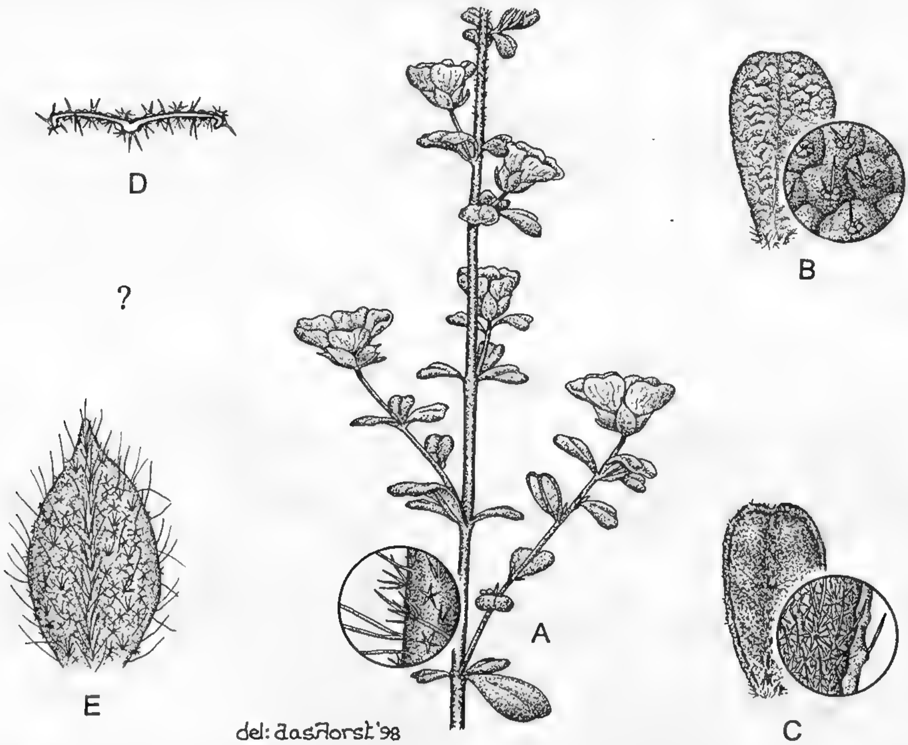

Fig. 10. ***H. notabilis***. **A**, Flowering branch showing flowers terminal on branches and short shoots ×1.5; **B–D**, adult leaf: **B**, above ×3; **C**, below ×3; **D**, transverse section ×5; **?** = juvenile and/or intermediate stage leaf unknown; **E**, outer calyx lobe ×9. (**A–E**, *D.E. Albrecht 1037*, MEL).

Distribution and ecology

Found in open forest of *Eucalyptus sieberi* and *Angophora floribunda* on the coastal ranges on either side of the border between New South Wales (SC) and Victoria (EG).

Conservation status: Known only from two specimens both from within conservation parks.

Diagnostic features

H. notabilis is superficially very similar to *H. aspera* by its discolourous obovate leaves with rarely rounded apex, flowers on short shoots, bracts shorter than half the outer calyx lobes, and shortly acuminate outer calyx lobes, all characters by which it can be distinguished from the one or other form of *H. hirticalyx*, which occurs further south and west in Victoria and Tasmania. It is, however, characterised by its 10–12 stamens with oblong anthers 1–1.4 mm long and consistently 4 ovules per carpel unlike in *H. aspera*. The

tomentum of the upper surface of the leaves of the latter usually shows a predominance of multiangulate radial (rarely slightly antrorse in and around that locality) stellate hairs with 3–8 branches, while *H. notabilis,* similar to forms of *H. hirticalyx* from northern Tasmania and here probably its true affinties should be sought, has mainly simple hairs interspersed with a few erect antrorse stellate hairs with 1–3 branches. *H. hirta* in contrast has mainly simple hairs on the leaves.

Too little is known about the variation of this taxon to evaluate its full affinities. Subspecific rank may seem more appropriate for this extremely localised taxon, but it was made a full species because of its remarkably intermediate characteristics between *H. aspera* and *H. hirticalyx.*

Etymology

The epithet 'notabilis", Latin, remarkable or noteworthy, referring to the noteworthy importance of the number of stamens in this group of hibbertias as shown by this species in spite of its superficial resemblance to *H. aspera.*

Specimens examined

NEW SOUTH WALES: *D.E. Albrecht 1037,* Nadgee Nature Reserve, 28.ix.1984 (MEL).

VICTORIA: *J.H. Willis MEL 695404,* Howe Ranges, 24.x.1948 (MEL).

H. pallidiflora Toelken, J. Adelaide Bot. Gard. 16: 68 (1995).

Type: South Australia, southern Yorke Peninsula, along Hillock Road, *H.R. Toelken 8567,* 2.x.1994 (holo.: AD; iso.: B, CANB, G, K, MEL, MO, NSW, NY, S).

H. billardierei F. Muell., Pl. Indig. Col. Vict. 1: 14 (1862), partly; Second Syst. Cens. 1 (1889), partly, as for syntype: near Rivoli Bay, *F. Mueller MEL 31526, 31527* (cf. typification: *H. apppressa*), *"Billardierii", nom. illeg., nom. superfl.*

H. billardierei auctt. non F. Muell.: Tate, Trans. Proc. Rep. Roy. Soc. S. Australia 3: 50 (1880), *"Billardieri"*; Trans. Proc. Rep. Roy. Soc. S. Australia 12: 70 (1889), partly, *"Billardieri"*; Fl. Extratrop. S. Austr. 14 (1890), partly, *"Billardieri"*; Trans. Proc. Rep. Roy. Soc. S. Australia 13: 116 (1890), *"Billardieri"*; J.M. Black, Fl. S. Austr. edn 1, 3: 387 (1926), *"Billardieri"*; edn 2, 3: 576 (1952), *"Billardieri"*.

H. aspera auctt. non DC.: H. Eichler, Suppl. Fl. S. Austr. 227 (1965); Jessop in Jessop & Toelken, Fl. S. Austr. edn 4, 1: 355 (1986), partly.

H. sp. C. Toelken in Jessop, List Vasc. Pl. S. Austr. edn 4, 28 (1993).

Usually dense shrubs with scrambling branches often up to 1.5 m long or rarely up to 4 m high, becoming more or less branched, pubescent to tomentose. *Vestiture* on branches and calyx persisting, with few larger multiangulate radial stellate hairs (>18 similar branches) with broader span than of smaller stellate hairs, often with raised tubercle over a range of smaller multiangulate radial stellate hairs (4–12 similar branches) with small tubercles; on *leaves above* like branches but larger hairs mainly towards the flanks, all without obvious base cells; on *leaves below* like branches except for larger hairs mainly on the flanks and central vein but occasionally also on the undersurface; *juvenile leaves* above with fewer multiangulate, often antrorse stellate hairs (with 1–3 longer similar branches) under/with few larger multiangulate radial hairs (6–12 similar branches) along the flanks while on leaves below only hooked simple hairs are present on the undersurface (few small and larger multiangulate radial stellate hairs restricted to flanks and central vein) become gradually replaced by more stellate hairs as the plant matures. *Leaves* without axillary tuft of hairs; *petiole* 0.2–0.9 (-1.6) mm long; *lamina* obovate to oblanceolate or elliptic oblanceolate, (1.8-) 2.3–10.4 (-13.1) × 0.9–6.5 (-7.2) mm, rounded, rarely obtuse, with apex of central vein sometimes mucronate, more or less abruptly tapering into petiole, pubescent, puberulous to glabrescent, usually pale green or discolourous when young; margins more or

less recurved. *Flowers* abruptly constricted into peduncle (buds oblong-obovoid before opening), terminal on all branches(short shoots rarely present), usually with 2 or 3 subwhorled leaves but on main branches peduncle often more or less connate to the developing axillary branch (concaulescence, see variation below) so that flowers appear not connected to any node with leaf (see fig.11A), rarely leaf-opposed on young branches and not seen repeated; *peduncle* (0.8–) 2.2–9.5 (–14) mm long and recurved when flowering, then spreading and ultimately ±recurved when fruiting, stellate-pubescent; *bracts* subtending calyx, linear-subulate, 1.2–2.2 × 1.5–2.5 mm, about half as long, rarely just longer than half as long as calyx, stellate-puberulous. *Calyx* pale green: *outer sepals* ovate to lanceolate, 2.1–3.9 mm long, acuminate to long-acuminate, outer surface pubescent to tomentose, inner surface minutely antrorse stellate-pubescent towards the apex; *inner lobes* ovate to broadly oblong-ovate, 2.1–3.5 mm long, acuminate to rounded with subterminal mucro, pubescent. *Petals* oblong-obovate to almost depressed obovate, 1.3–2.5 mm long, rounded to more or less bilobed, smooth, cream to pale yellow turning rusty-orange when dry. *Stamens* (6–) 8–13 in one cluster; *filaments* basally connate; *anthers* narrowly obloid, 0.5–0.8 mm long, with incurved terminal appendages, dehiscing mainly by introrse slits. *Pistils* 2, each with 2 (3) ±ventral ovules and with terminal styles elongating so that the stigmas are positioned beyond the apex of the anthers towards the mouth of the petal tube, ovary tomentose, with erect stellate hairs. *Seeds* shiny chestnut to pale brown, with membranous white aril more or less lobed on the lower third. *Flowers*: Aug.–Nov. (Dec.). Figs. 2C; 11A–K.

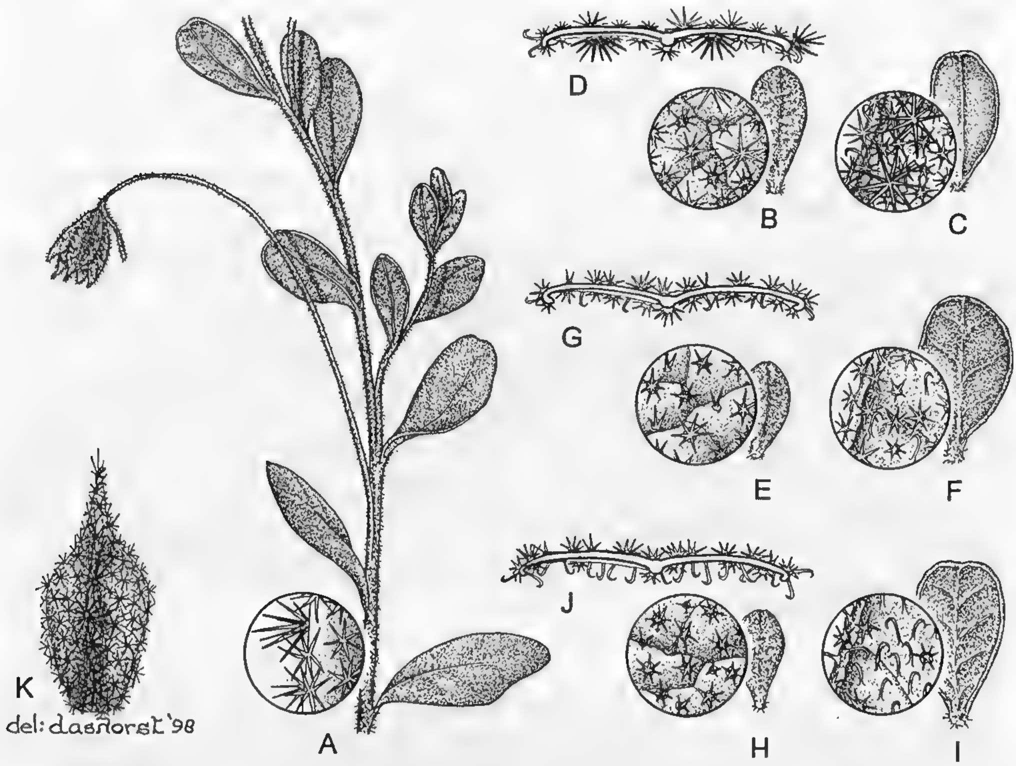

Fig. 11. ***H. pallidiflora.*** **A**, Fruiting branch with second subwhorled leaf and peduncle shifted ×3; **B–D**, adult leaf: **B**, above ×3; **C**, below ×3; **D**, transverse section ×8; **E–G**, intermediate stage leaf: B, above ×3; **F**, below ×3; **G**, transverse section ×8; **H–J**, juvenile leaf: **H**, above ×3; **I**, below ×3; **J**, transverse section ×8; **K**, outer calyx lobe ×9. (**A–D**, **K**, *B. Copley 4302*, AD; **E–J**, *P. Martensz 276*, AD).

Distribution and ecology

Grows usually on moist sandy to gravelly soils, sometimes close to temporarily flooded areas, commonly associated with limestone mainly in scrub of coastal heath or mallee vegetation in south-western Victoria (WAN) and South Australia (YP, SL, KI, SE).

Conservation status: Conserved in a number of parks in Victoria and South Australia, but herbarium material does not give an indication on how common the species is, as it is not often collected because of its small recurved flowers.

Diagnostic features

Among the species with usually 10–12 oblong anthers, *H. pallidiflora* is easily distinguished by its pale yellow petals being shorter than the calyx and remaining tubular (not opening widely), as well as by its long styles placing the stigmas well above the anthers at the mouth of the petal tube. Vegetatively it is distinguished from *H. cinerea,* the only other species in that group that has larger stellate hairs over smaller ones (without simple hairs) on the calyx and by its scrambling habit.

Variation

An extremely variable species in its vegetative characteristics, from a small shrublet up to 30 cm tall to scramblers to 1.2 m or in one record up to 4 m high, or leaves varying from 1.8–14 mm long, but most variable is the vestiture on the leaves.

In the case of *H. pallidiflora* the stellate hairs on the leaves are extremely variable. On top of small leaves usually of depauperate plants (with leaves 2–4.5 mm long) the stellate hairs are usually small and with 5,6 (7) branches each of which is scarcely longer (0.05 mm long: *B.M. Overton 166*) than the basal tubercle, while in the other extreme in plants from sheltered conditions leaves are up to 13.8 mm long, the 1–3 branches are up to 12 times the length of the tubercle (to 5.2 mm: *R.J. Bates 7620*).

Flowers are as in most other species subtended by two or three subwhorled leaves, i.e. predominantly three leaves on specimens from Kangaroo Island and often only two on plants from the mainland. When flowers are terminal on growing main branches (with long internodes) particularly on plants from the southern Yorke Peninsula they do not appear to be associated with any leaves, but when one examines young flower buds they are like those on short branches on the same plant subtended by usually 2 subwhorled leaves. As the flowers mature or particularly when the axillary branches develop, the internodes elongate, so that the whole branch system is distorted. The petiole of the one leaf and even sometimes the stalk of the flower is partly connate to the developing branch (concaulescence: Weberling 1989, p. 217) as shown by the elongate flanges or ridges. True leaf-opposed flowers are rare and remain in that position even in fruiting material, but are normally associated to very young branches with extreme juvenile leaves. No apparent reason could be found why only very few young branches produce leaf-opposed flowers, but some are also distorted as described above.

Notes

The first specimen of *H. pallidiflora* was collected in October 1848 by F. Mueller "towards Rivoli Bay" and was used as a syntype for his *H. billardierei* (cf. typification: *H. appressa*). Tate (1890) also probably referred to this record under that species name when he marked it present from the "Mount Gambier district", but his record from the "Adelaide district" cannot be explained in terms of specimens seen during the present study. Both these records were probably communicated to him by F. Mueller as mentioned in Tate (1880), because the earliest specimen from the Fleurieu Peninsula, from where both species have now been recorded, dates from 1929 (*J.B. Cleland AD 97044051*).

The record of *H. billardierei* from Kangaroo Island in Tate (1889, 1890) probably referred to his own collections of *H. empetrifolia* subsp. *radians* (cf. Tate 1883, 1889a). It is unlikely that he had seen Tepper's specimens of both, the latter species and *H. pallidiflora* collected in 1886/7 on Kangaroo Island (MEL). However, Tate did name a specimen of *H. pallidiflora* he collected in 1889 on the southern Yorke Peninsula *H. billardierei* (Tate 1890a) without further reference to any varieties distinguished by Bentham (1863).

The first collection of *H. pallidiflora* from Victoria was made at the "entrance of the Glenelg River" in 1891 by L. Eckert (MEL 31539), but only few specimens have been collected since from this south-western corner of this State.

Voucher specimens (88 specimens examined)

VICTORIA: *A.C. Beauglehole 8245*, Bats Ridges, Portland 29.x.1960 (CANB, MEL); *M.E. Phillips CBG 12248*, Mount Richmond National Park (CANB).

SOUTH AUSTRALIA: *P. Gibbons 600*, 20 km NW Millicent, 18.x.1986 (AD, BRI, HO, MEL, MO, NSW, PERTH); *P. Martensz 276*, Kangaroo Island, 1.x.1970 (CANB, AD, MEL, L); *M.E. Phillips CBG 54707*, 6 miles NW Karatta, 30.ix.1965 (AD, CANB, NSW).

H. rhynchocalyx Toelken, *sp. nov.*

H. hirticalyci persimilis sed pilis simplicibus longis densis in ramis calycibusque, pilis stellatis perdensis in paginis abaxialibus foliorum et antheris mucronatis differt.

Type: New South Wales, Gibraltar Range, *J.B. Williams 603 & K. Winterhalder* (holo.: NSW; iso.: CANB; NE, n.v.).

Low shrubs with spreading branches moderately branched, pilose to velutinous. *Vestiture* on branches and calyx persisting, with usually many long more or less spreading simple hairs (rarely with 2 branches and up to 2 mm long) over larger and smaller erect/multiangulate radial stellate hairs (3–7 often unequal branches) with small tubercle and some base cells; on *leaves above* some wearing off, with scattered long simple hairs and and large erect radial/antrorse stellate hairs (2–6 often unequal branches) with small tubercles and some base cells over/between scattered short multiangulate radial or rarely antrose stellate hairs (2–7 similar branches) with small tubercle and few distinct base cells; on *leaves below* persisting, with few scattered (but particularly on the central vein) longer erect to multiangulate, radial fine stellate hairs (1–6 usually unequal branches) often with broader tubercle over overlapping multiangulate radial stellate hairs (5–12 similar branches) with small tubercle, and apparently no base cells; *juvenile leaves* unknown. *Leaves* with axillary tuft of long hairs because of latent axillary bud; *petiole* 0.5–2 mm long; *lamina* oblong-elliptic to oblong-lanceolate, 7–22.4 × 2.7–7.2 mm, truncate and more or less emarginate, gradually tapering into petiole, hirsute to glabrescent above, often discolourous; with margins recurved to recoiled with velutinous undersurface exposed between them and the often villous central vein. *Flowers* abruply constricted into peduncle (buds oblong-obovoid before opening), terminal mainly on short lateral branches (no short shoots) subtended by 2 or 3 subwhorled leaves sometimes leading to dichotomous branching, apparently not leaf-opposed; *peduncle* 3.2–6.4 mm long and spreading, hirsute; bracts subtending calyx, linear-subulate, 4.4–5.1 mm, two-thirds to almost as long as the calyx, hirsute. *Calyx* pale green: *outer lobes* lanceolate to ovate, 4.8–6.1 mm long, long-acuminate, outer surface usually villous, innner surface sericeous with long soft simple hairs over mainly forward-directed stellate hairs; *inner lobes* broadly oblong to oblong-obovate, 4.7–5.2 mm long, usually rounded with subterminal mucro, villous to pubescent. *Petals* obovate-spathulate with cuneate base, 4.5–6.6 mm long, more or less bilobed, yellow. *Stamens* 12 in one cluster; *filaments* connate for most of their length; *anthers* narrowly obloid, 1.2–1.4 mm long, each with terminal appendage, dehiscing by introrse slits. *Pistils* 2, each with 2 ventral ovules, and with short terminal styles positioning the stigmas just

below the apex of the central anthers, ovary tomentose to villous with erect stellate hairs. *Seeds* not seen. *Flowers*: Oct. Figs. 2D; 12A–E.

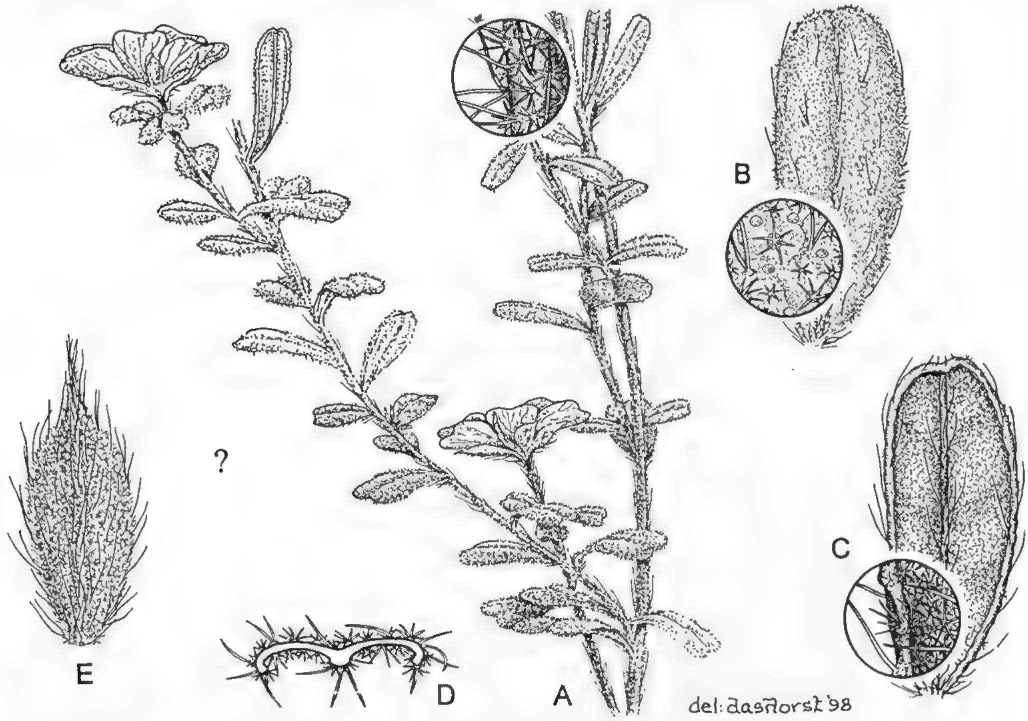

Fig. 12. ***H. rhynchocalyx.*** **A**, Flowering branch ×1; **B–D**, adult leaf: **B**, above ×3; **C**, below ×3; **D**, transverse section ×3.5; ? = juvenile and/or intermediate stage leaf unknown; **E**, outer calyx lobe ×10. (**A–E**, *J.B. Williams 603*, NSW).

Distribution and ecology

Grows on sandy soil on granite in sheltered places on east facing slopes in dry sclerophyll forest of mainly *Eucalyptus resinifera* on the Gibraltar Range (New South Wales, NC).

Conservation status: Known only from one collection.

Diagnostic features

Shows a very close similarity to *H. hirticalyx,* even to the extent that both species are usually found in association with granite, but *H. rhynchocalyx* is distinguished by its very dense hair cover on branches, calyx with rather long and stiff simple hairs (hispido-tomentose), and stellate-velutinous (hairs strongly overlapping) undersurface of the leaves, as well as the distinct appendage terminal to the connective of each anther. Unlike *H. hirta*, which has only long spreading simple hairs covering both sides of the leaves, *H. rhynchocalyx* has at least some stellate hairs above and below. The leaves are superficially similar to forms of *H. aspera*, because they are discolourous with a stellate-velutinous undersurface and the hairs are often more or less erect-stellate with a raised tubercle as in subsp. *pilosifolia*, but *H. rhynchocalyx* has terminal flowers (no short shoots) with long simple hairs on the calyx, and twelve stamens each with a distinct terminal appendage.

Etymology

The epithet is derived from Greek, 'rhynchos', beak and 'calyx', 'the covering of a flower' or calyx, and refers to the beaked outer calyx lobes accentuated by the long hairs on them.

Voucher specimens: Known only from the type collection.

H. truncata Toelken, *sp. nov.*

H. aspera auctt. non DC.: N.A. Wakef., Vict. Nat. 73: 167 (1957), partly; J.H. Willis, Pl. Vict. 2: 391 (1973), partly; Hoogland, Kew Bull. 29: 155 (1974), partly; Toelken in N.G. Walsh & Entwisle, Fl. Vict. 3: 312 (1996), partly.

H. asperae similis sed duodecim staminibus et absentia piliorum simplicissimorum in foliis; a *H. cinerea* pilis parvulis disparsis in paginis superis foliorum, foliis plerumque truncatis fructicibusque decumbentibus differt.

Type: Victoria, Port Campbell, *R.J. Adair 1134*, 10.iii.1980 (holo.: MEL; iso: CANB).

Shrublets with decumbent to prostrate branches up 0.4 m high, more or less densely branched, pubescent to tomentose. *Vestiture* on branches and calyx persisting, with few larger multiangulate radial stellate hairs (> 20 similar branches) with broader and raised tubercle over/between often a range of smaller multiangulate radial (rarely somewhat antrorse at the base of leaves) stellate hairs (5–15 similar branches) with small tubercle-base and few base cells; on *leaves above* like branches but larger hairs only towards the flanks; on *leaves below* like branches but denser, overlapping, and with larger hairs restricted to flanks and central vein; on *leaves of coppicing branches* (*H.R. Toelken 9251*) above with few widely spaced stellate hairs (often 1–5 branches except for few multi-branched ones on the flanks) and soon wearing off, below with few stellate hairs mainly along the flanks and central vein but also very few on the undersurface between many hooked simple hairs on first leaves, but rapidly increasing on subsequent leaves. *Leaves* without axillary tuft of hairs; *petiole* 0.4–1.2 mm long; *lamina* broadly obovate, 3.5–16 (-19.4) × 2–12 (-16.2) mm, with apex truncate, often apiculate, rarely emarginate or rounded, ± abruptly tapering into petiole, above pubescent to puberulous or rarely glabrescent with age, below velvety, discolourous; margins usually scarcely recurved exposing undersurface and scarcely raised central vein often projected into an apiculum. *Flowers* abruptly constricted into peduncle (buds broadly ellipsoid before opening), often terminal on short shoots and usually subtended by 2 or 3 subwhorled leaves leading to dichotomous branching and/or more than one flower from the same area, apparently not leaf-opposed along actively growing shoots; *peduncle* 3–16 (-22) mm long and erect when flowering, recurved when fruiting, more or less densely pubescent with usually larger and smaller stellate hairs; *bracts* subtending calyx, linear-subulate, 1.3–1.5 (-1.8) mm, usually half the length of calyx or less, velvety. *Calyx* with *outer lobes* ovate, 3.6–5 mm long, acute, rarely short-acuminate, outer surface tomentose to pubescent, inner surface coarse pubescent with multiangulate radial stellate hairs; *inner lobes* broadly elliptic, rarely ovate, 3.8–4.8 mm long, rounded to truncate and apiculate, tomentose to pubescent. *Petals* usually obovate, 6–10.6 mm, bilobed, slightly papillose, yellow. *Stamens* 10–12 in one cluster; *filaments* usually connate less than half their length; *anthers* narrowly obloid, 1.1–1.3 mm long, with incurved terminal appendage, dehiscing mainly by introrse slits. *Pistils* 2, each with (4) 5, 6 ventral ovules, with terminal style positioning stigmas near the apex of the central anthers, ovary shaggy with erect, mainly stellate hairs. *Seeds* not seen. *Flowers*: Sept.–Nov. Figs. 2A,B; 13A–K.

Distribution and ecology

Growing on sandy soil or sometimes sand dunes, often locally common, usually associated with limestone in coastal heath, rarely more inland; recorded only from a few

localities in the vicinity of Peterborough and Port Campbell, Victoria (OTPL). In the latter area it is one of the dominant plants of the local coastal vegetation.

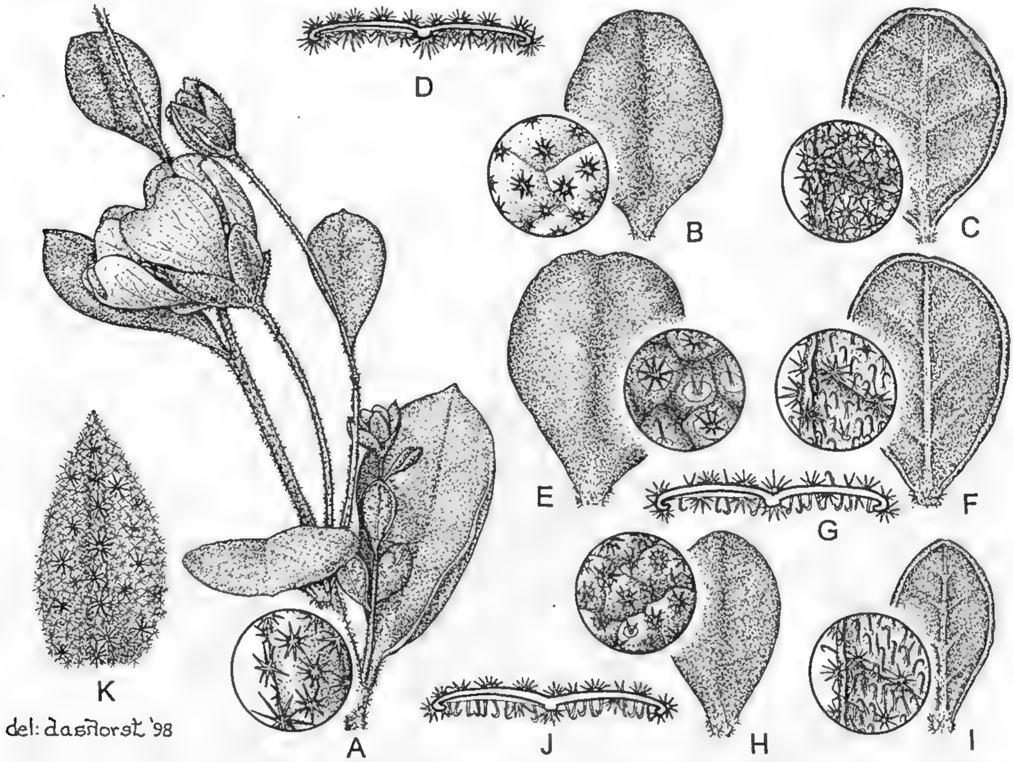

Fig. 13. ***H. truncata***. **A**, Flowering branch with terminal flowers on branches and short shoots ×3; **B–D**, adult leaf: **B**, above ×3; **C**, below ×3; **D**, transverse section ×4; **E–G**, intermediate stage leaf: **E**, above ×3; **F**, below ×3; **G**, transverse section ×4; **H–J**, juvenile leaf: **H**, above ×4; **I**, below ×4; **J**, transverse section ×8; **K**, outer calyx lobe ×9. (**A–D**, **K**, *B.G. Briggs 2954*, NSW; **E–J**, *H.R. Toelken 9251*, AD).

Conservation status: Locally common and conserved in Port Campbell National Park.

Diagnostic features

Superficially similar to *H. aspera* because of the combination of sparse radial multiangulate stellate hairs above and dense overlapping stellate hairs below, but is distinguished by usually producing 12 stamens as well as by the absence of simple hairs on adult plants mainly towards the base of leaves but also on the flanks and along the central vein. It is distinguished from *H. cinerea*, which also has a similar larger numbers of stamens and no simple hairs, by its small scattered hairs on the upper leaf surface and which often wear off to retain only the broad basal tubercles. The broadly obovate leaves with a truncate or emarginate apex are characteristic of the species.

Variation

The species shows an enormous range of variation in one population (*H.R. Toelken 9252*) in the size of the whole plant (decumbent shrublets scarcely 0.3 cm high to scramblers with branches up to 2.2 m long), the broadly obovate leaves (from 4.4 × 2.3 mm at the apex of senescing branches to 21.1 × 14.4 mm on actively growing branches or 32.4 × 18.1 mm (*H.R. Toelken 9251*) on coppice shoots), and the flowers with petals 4.6 – 11.3 mm long.

The vestiture is, however, remarkably constant except for the first few leaves (apparently rarely more than six leaves and which are usually lost soon) on coppicing branches and presumably also an the juvenile leaves. The first of these leaves has mainly hooked simple hairs and only a few stellate hairs on the flanks and central vein, but the number of stellate hairs rapidly increases on subsequent leaves and soon replace the simple hairs completely. Simple hairs were, however, not observed on coppicing branches, which were more sparsely covered with small and larger stellate hairs than is usual on adult plants.

Notes

The epithet 'truncata', Latin, refers to truncated or abruptly ending leaf apices accentuated in this species by the usually rather broad-obovate leaves.

Although J.H. Willis had annotated in 1944 a herbarium specimen of this taxon as *H. billardierei* var. *latifolia* var. nov., Wakefield (1957) seems to have included this form in his wider concept of *H. aspera.*

Voucher specimens (14 specimens examined)

VICTORIA: *A.C. Beauglehole 21026 & E.W. Fink*, Port Campbell National Park, 5.ix.1966 (MEL); *B.G. Briggs 2954*, near Port Campbell, 23.x.1969 (NSW); *H.B. Williamson s.n.*, Port Campbell, -.x.1917 (MEL).

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A NEW SPECIES *LINDERNIA COWIEI* AND THE VARIABILITY OF *L. TENUIFOLIA* (SUBG. *BONNAYA*: SCROPHULARIACEAE) IN NORTHERN AUSTRALIA

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Abstract

Lindernia cowiei, a new species of Subg. *Bonnaya* from Melville Island, Northern Territory, is described. It is most closely allied to *L. tenuifolia*, a species from southeast Asia and Malesia which also occurs in the far northern coastal regions of Northern Territory and Queensland. A discussion of relationships and a key and known geographical and ecological distribution of the two Australian species is provided. Variation of *L. tenuifolia* in Australia encompasses *L. viatica*, another southeast Asian species distinguished in the past 20 years, but variation within populations in Australia does not support its separation at the level of species.

This paper has been prompted by the need to name a new species in Subg. *Bonnaya* for a treatment of *Lindernia* in the forthcoming *Flora of the Northern Territory Flood Plains*. In addition the taxonomy of its closest relative, which also occurs in the same region, is discussed.

Lindernia is a genus which has been poorly understood in Australia. A taxonomic revision being undertaken by the author will increase the representation of species from ten known by the 1980s (Hnatiuk 1990: from information on existing published knowledge supplied by W.R. Barker and Australian herbaria) to over 40 (W.R. Barker, in preparation).

This is the fourth publication precursive to the Australian revision of the genus. Six new species and a new combination were described in an earlier paper (Barker 1990) for inclusion in the *Flora of the Kimberley Region* (Barker 1992a). The treatment of *Lindernia* in the *Flora of New South Wales* (Barker 1992b) separated *L. procumbens* (Krock.)Philcox, a new Australian record, and *L. alsinoides* R.Br., which had been confused under the latter name in New South Wales and southeast Queensland. In addition, records of species not previously included in Australian literature, such as *L. tenuifolia* and *L. viatica* (misspelled as *"vitacea"* following Yamazaki 1981), and manuscript names arising from successive editions of a draft conspectus and key to *Lindernia* in Australia (Barker, unpubl.), distributed to Western Australian, Northern Territory and Queensland botanists to enhance understanding and collecting activity, have been included in recent publications. These include censuses of Northern Territory (Dunlop et al. unpubl.) and the Kakadu and Alligator Rivers area of Arnhem Land (Brennan 1996) and the Australian listing of rare and endangered species (Briggs & Leigh 1996).

Important to the understanding of these species has been the key regional works on *Lindernia* of Philcox (1968) dealing with Malesia and Yamazaki (1981, 1985) dealing with parts of southeast Asia. Both record Australian occurrences of various Asian and Malesian species.

In determining distribution and ecology, I have seen much material in the Herbarium of the Northern Territory (DNA, NT), the Western Australian Herbarium (PERTH) and the State Herbarium of South Australia (AD), with some from the National Herbarium of Victoria (MEL) and the National Herbarium of New South Wales (NSW). Queensland material is represented by exchange material from the Mareeba branch of the Queensland Herbarium (MBA).

Relationships of the new species

The new species *L. cowiei* belongs to Sect. *Bonnaya* (Link & Otto)Philcox within Subg. *Bonnaya* (Link & Otto)Yamazaki which is characterised by lax inflorescences, deeply lobed calyces, and filiform staminodes (Yamazaki 1981). From Australian material examined and Yamazaki's (l.c.) and Philcox's (1968) works in particular amongst Asian and Malesian treatments of *Lindernia* studied, it differs from *L. antipoda*, *L. ciliata* and *L. ruellioides* by its subentire to sparingly and obscurely serrate leaf teeth with teeth not sharply acute. These characters ally it to *L. tenuifolia* (including *L. viatica*) and *L. succosa*, the latter of which differs by its fleshy leaves and ovate calyces. The new species differs from all by its much larger, showy corolla. The closest allied species, *L. tenuifolia*, including variants attributable to *L. viatica*, is known also from northern Australia. In particular both occur on Melville Island, the only known record of the new species. A key to these closely allied species is provided.

Variation in *L. tenuifolia* in northern Australia and its taxonomic implications

From examination of Australian collections, it seems clear that *L. viatica* and *L. tenuifolia* are conspecific. The characters separating them, namely the arrangement of flowers in the inflorescence, the corolla length and width of lower lobe, and plant height (see key), appear relatively trifling, at least the inflorescence character breaking down on robust, relatively tall individual plants. From the specimens seen they have very similar ranges of distribution habitat and flowering times.

With the two species recognised in the literature (Philcox 1968; Yamazaki 1981, 1985) as extending widely in southern Asia, it is important that material and if necessary populations from there be studied to ensure that the same situation prevails or whether some infraspecific recognition is warranted.

Key distinguishing the new species *L. cowiei* from the widely variable *L. tenuifolia* in Australia

1a. Flowers single at a node, opposed by a small leaf; corolla 3-4 mm long along upper side, the middle lobe of the lower lip c. 1.5—2 mm wide; plant to 6 cm high .... *L. tenuifolia* (Colsm.)Alston (s.str.)

1b. Flowers paired at nodes; corolla 7—10 mm long along upper side; plants to 40 cm high

 2a. Corolla 8.5—10 mm long along upper side, the middle lobe of the lower lip c. 6 mm wide; leaves entire to bluntly serrate, with several main veins at base .... *L. cowiei* W.R.Barker

 2b. Corolla 5—7 mm long along upper side, the middle lobe of the lower lip c. 2 mm wide; leaves entire to very shallowly undulate, with a single main vein .... *L. tenuifolia* (Colsm.)Alston (variation formerly attributed to *L. viatica* (Kerr ex Barnett)Philcox, here synonymised)

Lindernia cowiei W.R. Barker, sp. nov.

"*Lindernia D123061 Goose Creek*": Dunlop et al., Checkl. Vasc. Pl. N.Terr. ,Austral. (1995) 102.

Species nova subgeneris *Bonnaya* sectionis *Bonnaya*, *L. tenuifoliae* (Colsm.) Alston, *L. viaticam* (Kerr ex Barnett) Philcox inclusantem, affinis, sed differt floribus formosis labio infero maiore.

Holotypus: *I.D. Cowie 5518 & G. Bellis*, 30 Mar 1995, Northern Territory, Darwin & Gulf region: Melville Island, Goose Creek Floodplain, DNA123061. ***Isotypi***: AD99530159; AD99530160; (n.v.) MEL.

Semi-aquatic annual herb 35–60 cm high; stem erect to ascending, with branches sometimes arising from the widely spaced lower nodes, rounded in spirit material, quadrangular in dried, with a cluster of short pale roots at base. Leaves narrow linear to narrowly obovate, 25–50 mm long, 2–5 mm wide, narrow cuneate, entire, coarsely undulate

or sparsely unevenly bluntly serrulate, bluntly acute, glabrous, the bases of a pair joined across node: venation of palmate type, the main veins distally parallel. Flowers over 10, opposite, in terminal open racemes; bracts subulate, 1–2 mm long; pedicels 10–23 mm long, ascending. Calyx 2.5–3.5 mm long, glabrous, with sepals entire with a narrow membranous margin. Corolla 8.5–10 mm long along upper side, mauve with white centre; tube 4–5 mm long; hood narrow triangular, 4.5–5 mm long, c. 2.5 mm wide; lower lip widely spreading, c. 6 mm long, middle lobe c. 6 mm wide, lateral lobes c. 4.5 mm wide, with two longitudinal ridges behind the abaxial staminodes. Stamens: adaxial pair functional, the anthers borne under hood, 2-celled, the cells divergent, ellipsoid, 0.7 mm long, not awned; abaxial pair reduced to two staminodes at base of lower corolla lip, the connective oblique on the filament, depressedly deltoid; staminodes prominent, without vestigial anthers, the free part 1.5 mm long when straightened, the distal ⅔ linear, uncinate (obliquely C-shaped), the base dilated. Stigma borne distally of adaxial anthers, together appressed under the corolla hood. Capsule borne on deflexed pedicels 15–20 mm long, narrowly ovoid-cylindrical, to 12 mm long, 1 mm diameter. Seeds finely reticulate. Fig. 1.

Distribution and ecology

Known only from the type collection. "Goose Creek", Melville Island, is a local name for Andranangoo Creek on topographic maps (Mr I. Cowie, pers. comm. June 1998). It was located on a seasonally inundated floodplain (of the drier type), along a channel in a tidally influenced area, with *Eleocharis dulcis* in 20 cm of water.

Phenology: Flowering and fruiting occurs in at least March – April, the single March 30 collection being in full flower, with some fruits and plenty of buds.

Conservation status: 1K (coding following Briggs & Leigh 1996: indicating that it is known from the type only and that its distribution is inadequately known).

Etymology: The species is named in appreciation of its discoverer's considerable efforts to increase the knowledge of *Lindernia* in Northern Territory over the past decade.

L. tenuifolia (Colsm.)Alston in Trim., Fl. Ceyl. 6, Suppl. (1931) 214; Dunlop et al., Checkl. Vasc. Pl. N. Terr., Austral. (1995) 102; Brennan, Annot. Checkl. Vasc. Pl. Alligator R. Reg., N. Terr., Austral. (1996) 96.
Gratiola tenuifolia Colsm., Prod. Desc. Grat. (1793) 8, basionym.
Holotype: *Koenig s.n.*, Ceylon, C (n.v.: Philcox 1968).

L. viatica (Kerr ex Barnett)Philcox, Taxon 19 (1970) 649; Yamazaki, J. Fac. Nat. Sci. Univ. Tokyo, Bot. 13 (1981) 53 "*vitacea*"; Dunlop et al., Checkl. Vasc. Pl. N. Terr., Austral. (1995) 102 "*vitacea*"; Brennan, Annot. Checkl. Vasc. Pl. Alligator R. Reg., N. Terr., Austral. (1996) 96 "*vitaceae* Kerr, Barnett & Philcox";
Ilysanthes viatica Kerr ex Barnett, Kew Bull. 16 (1963) 489, basionym.
Holotype: *Kerr 19604*, Thailand, Aran Pratet, K (n.v.).

Distribution and ecology

In Australia *L. tenuifolia* in its broader sense is apparently a native, occurring in the near coastal fringe of Northern Territory from towards the border with Western Australia in the Fitzmaurice River, to Melville Island and Darwin area, in the Alligator River floodplains, and then to east Arnhem Land, and on Cape York in far north Queensland.

Outside Australia it occurs from Sri Lanka and India to South China, Taiwan, Cambodia, Vietnam, Laos, Thailand, and the Malay Peninsula.

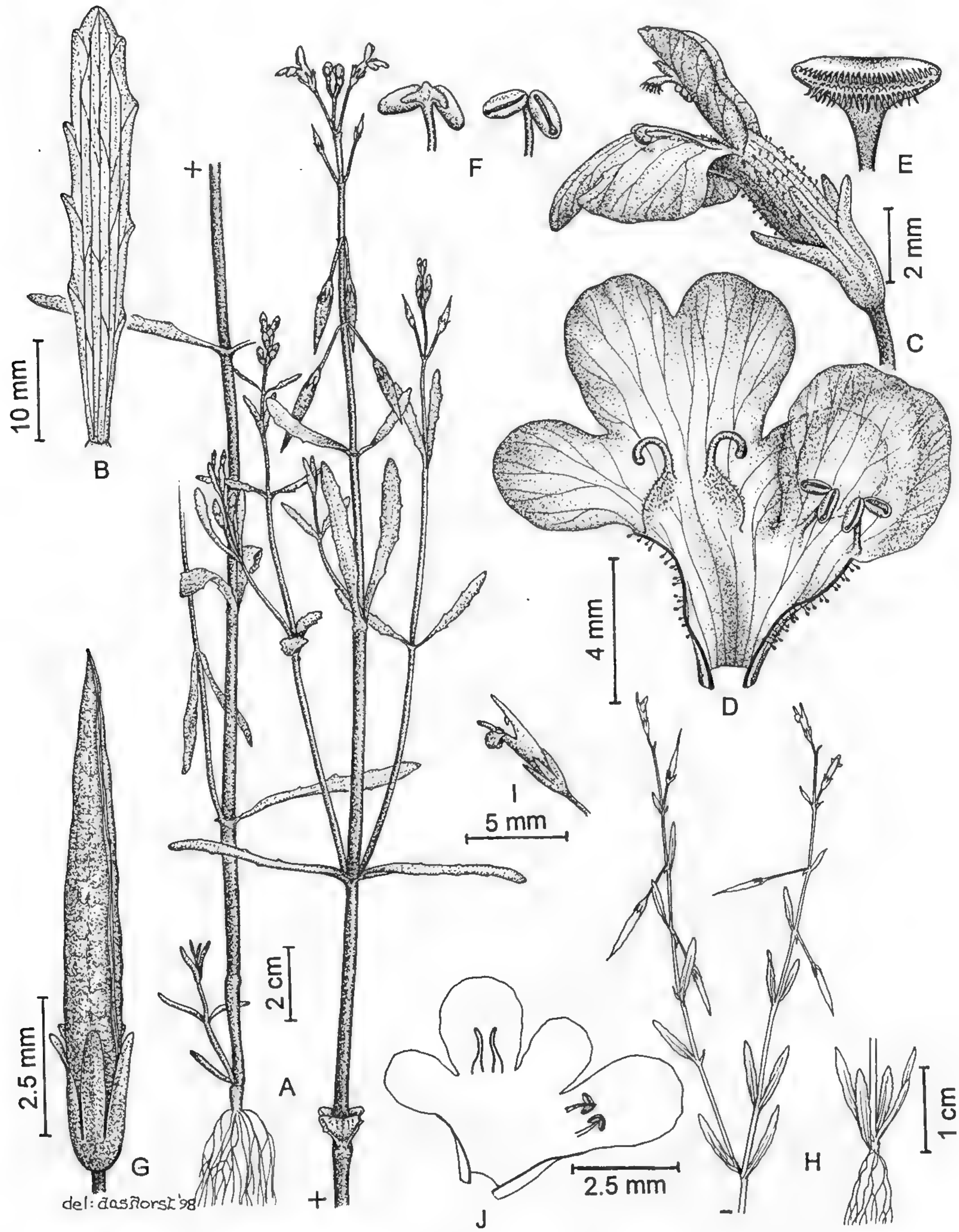

Fig. 1. A–G, ***Lindernia cowiei*** W.R.Barker, dwarf form. **A**, habit; **B**, leaf; **C**, flower; **D**, corolla open exposing stamens and staminodes; **E**, stigma; **F**, anthers, adaxial and abaxial side; **G**, capsule (*I.D. Cowie 5518 & G. Bellis*). **H–J**, ***Lindernia tenuifolia*** (Colsm.)Alston. **H**, habit; **I**, flower; **J**, corolla opened exposing stamens and staminodes (*R.M. Barker 423*).

The species occupies seasonally damp or inundated sites, usually coastal, sometimes more inland sites, behind mangroves, in swampy sites, along drainage lines, in sand flats or cracking clay of sedgeland flats, in cleared shrubland or open woodland or, in the Fitzmaurice River area, at the bottom of a sandstone slope.

Outside Australia the species is known from roadsides or paddy fields.

Phenology. Flowering and fruits are known from February to May.

Specimens examined

Dwarf forms attributable to *L. tenuifolia* s.str.

NORTHERN TERRITORY. DARWIN & GULF: *G. Leach 4115,* 21 Feb 1994, Fitzmaurice River, DNA; *I.D. Cowie 5524 & G. Bellis,* 30 Mar 1995, Melville Island, Jessie River, DNA; *P.K. Latz 3617,* 28 Apr 1973, Leanyer Swamp, Darwin, NT (partly); *R.M. Barker 423*, 5 May 1983, Kapalga, 4 km past airstrip, AD.)

QUEENSLAND. COOK: *A. Gunness 2313*, 12 Apr 1994, Namaleta Creek, S of Skardon River. AD, (n.v.) BRI; *A. Gunness 2510,* 22 Mar 1995, NW Cape York, Skardon River, AD.

Robust forms which formerly would have been attributable to *L. viatica*:

NORTHERN TERRITORY. DARWIN & GULF: *I.D. Cowie 5549*, 30.v.1995, Melville Island, Cape Fleeming, DNA; *G.J. Leach 2700*, 23 Mar 1990, Fog Bay, SW of Darwin, DNA, AD; *P.K. Latz 3617*, 28 Apr 1973, Leanyer Swamp, Darwin, NT (partly); *B. Harwood 31,* 10 Feb 1995, Holmes Jungle, DNA; *W.R. Barker 7058,* 1 Jun 1994, Howard Springs Park estate, pending subdivision c. 400 m down Parakeet Road from Bronzewing Road, 50 m N of road, AD (dupl. for distrib.); *R.M. Barker 438*, 5 May 1983, Kapalga ruins, near Kapalga landing, AD (2 sheets); *G. Wightman 10*, 4.vi.1982, Pandanus Point, Kapalga, AD; *J. Taylor 277,* 24 Mar 1981, Kapalga, DNA; *A.M. Buchanan 10395,* 17 May 1987, Mouth of Second Creek, Elcho Island, DNA; *I.D. Cowie 4076 & Leach*, 3 May 1993, E Arnhem Land, Cape Shield, DNA.

QUEENSLAND. COOK: *J. Clarkson 7776*, 14.ii.1989, Moa Island, c. 1 km NE of Kubin along road to St Pauls, MBA.

Acknowledgments

I am grateful to Ian Cowie for his help on detailing his experience of the habitats of the three species. Robyn Barker also provided valuable comments on a late revision of the paper. They and Ann Gunness and John Clarkson are thanked for their assistance in this paper with the provision of collections.

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J. Adelaide Bot. Gard. 18(2): 167-168 (1998)

BOOK REVIEW

Flora of Australia. Volume 12: Mimosaceae (excluding *Acacia*) Caesalpiniaceae pp. 192, figs. 96, maps 188. $A69.95 (hardback); $A54.95 (paperback).

This is the first of the volumes to deal with the legumes and the blurb says it provides descriptions of 38 genera, 153 species and 16 'form taxa' of which more below. It is thus one of the smaller volumes to-date and follows the format already established. There are a number of attractive colour plates, particularly the striking fruits of some of the tropical species less well known to southern taxonomists. Seven authors provide the text and one wonders if it was hurried at times. There is no mention of *Prosopis* occurring in South Australia despite a dozen sheets in the State Herbarium and its inclusion in the Flora of South Australia. Nor can I see why *Paraserianthes lophantha* requires two maps—one for Western Australia, the second for eastern Australia.

Many of the genera are small and with the exception of *Senna* only *Caesalpinea Chamaechrista* and *Labichea* have a dozen or more species, the latter having an intriguingly spare and attenuated distribution across Australia. Is it a relic of earlier happier days when Australia was wetter? The reduced anthers with their poricidal slits suggest specialised pollinators.

Of the 19 species included, about 37 are considered aliens—i.e. approximately 22%.

Attention is likely to be centered on *Senna*. Not only is it the most widespread genus (all States except Tasmania) but also it has the most species and the most problems. The genus has had three accounts in modern times, Symon (1966), Randell (1988, 1989, 1990) and Randell & Barlow this volume. Their account starts with a three page essay giving the background to the problems. This is nice to find in a National Flora which will have wide distribution overseas.

My own conventional revision exposed biological problems that were studied by Randell for her Ph.D. She disclosed rampant hybridity, polyploidy and agamospermy in many taxa in arid Australia. The 1966 revision treated these at species rank and acknowledged much diversity in some taxa, the cause of which was not then understood.

Randell's studies showed that the problems were confined to Section Psilorhegma ser. Subverrucosae of *Senna* and her account incorporated the new generic divisions proposed by Irwin & Barneby of *Cassia*, *Senna* and *Chamaecrista*.

Randell used standard taxonomic ranks and reduced the number of species by introducing a large number of subspecies under a few 'core' species as well as forms (informal) and some hybrid subsp. e.g. subsp. ×*coriacea*.

In this volume the use of subspecies is virtually abandoned. Many of Randell's subspecies become orthodox species or the decidedly non-orthodox form taxa (16 of them). The form taxa are not given a botanical authority but are all based on previously published names. These are not specifically cited as the type for the name though this might be implied. The authors state that 'form taxa' are "± recognisable entities which may not have genetic homogeneity or morphological continuity from population to population and which, therefore, lack predictiveness expected in a formal classification".

It will be interesting to hear how the various herbaria and databases cope with this new category.

After defining form taxa the authors make the decidedly odd statement: "This treatment is not intended to override Randell's taxonomic treatment of the genus which is still a valid formal resolution of the biological problem." Just what is meant? Follow Randell rather

than Randell & Barlow? If her treatment was a valid resolution of a biological problem why do we need yet another resolution—and one that makes many changes?

The earlier treatments were not wholly satisfactory as many of the subspecies were not subspecies in the normal sense of that word. Nor did the use of normal species and subspecies concepts alert the user to the complex problems of agamospermy.

Is there yet a satisfactory taxonomic way of coping with the innumerable products of agamospermy? Kalkman (1993) referring to *Rubus* says "The complex is taxonomically unsolvable ... because of facultative apogamy and easy hybridisation with stable progeny. It is possible to find the same 'taxa' year after year, to describe them, and to recognise differences with other neighbouring 'taxa'. Over a large area however it is impossible to reach a hierarchic classification with more or less equivalent taxa. Although batologists admit that their taxa are not comparable, they nevertheless try to classify them in the common scientific classification and with predictably poor results."

This account is an effort to get beyond that state but is not yet wholly satisfactory.

However one must be glad that the Editors of the Flora have been venturesome and allowed this foray into difficult territory.

For a further comment on these problems see my note in *Aust. Syst. Bot. Soc. Newsletter* 95(1998) p. 12 which was written before Vol. 12 was available to me. My own hand will be forced when *Rubus* is submitted and the authors for *Taraxacum* and *Poa* will also have to declare their philosophy, so this is a challenging treatment.

Many of the maps of distribution for *Senna*, particularly the form taxa, are presented as a black slab. They appear unsightly compared with all the other maps and seem to have an air of desperation about them as if the authors could not face, yet again, those myriad sheets of specimens whose placement anywhere is so difficult.

The volume is a welcome prelude to the volumes on fecund *Acacia* and our diverse array of papilionoid legumes yet to come.

D.E. Symon
State Herbarium of South Australia

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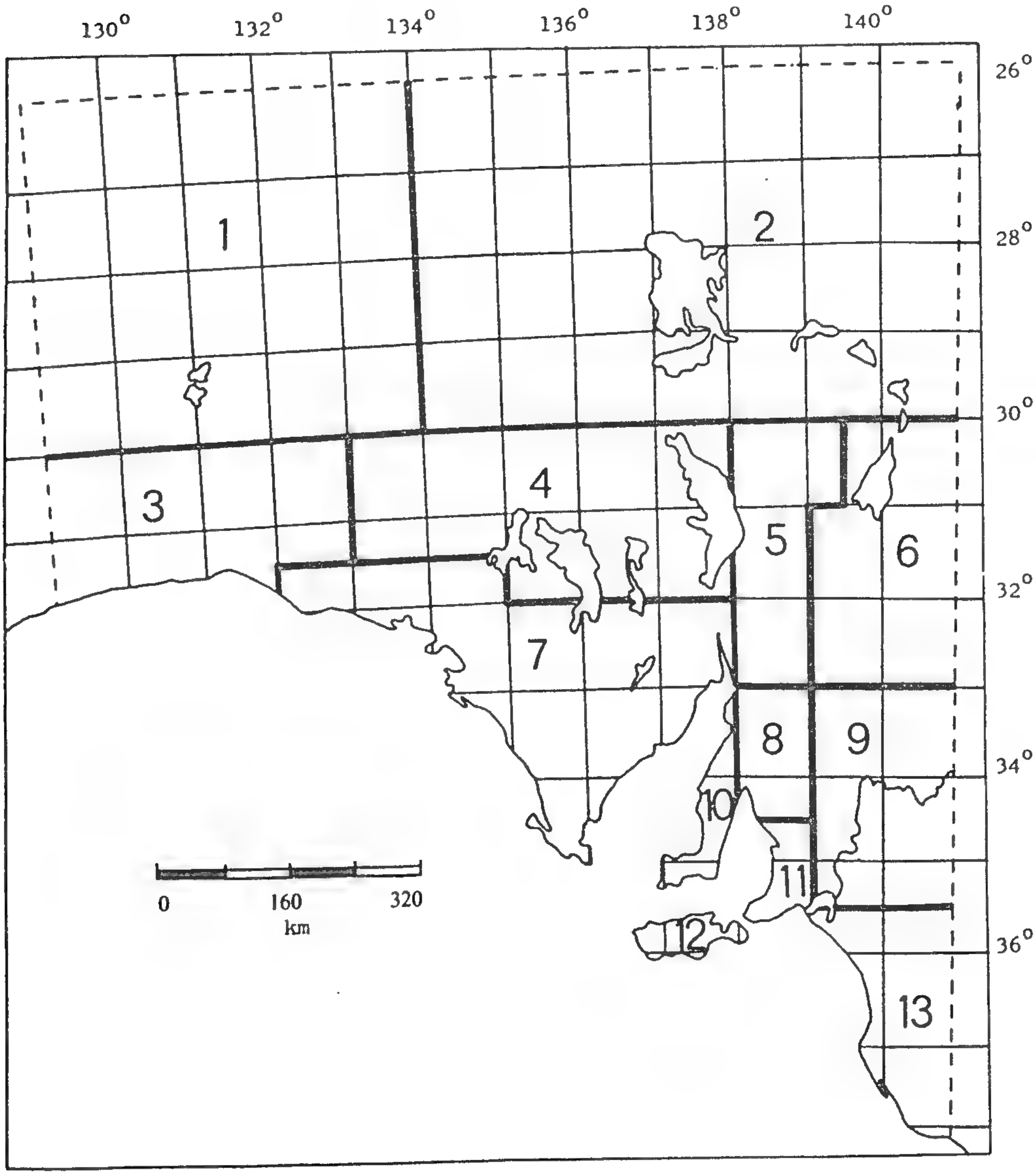
3. Nullarbor
4. Gairdner-Torrens
5. Flinders Ranges
6. Eastern
7. Eyre Peninsula
8. Northern Lofty
9. Murray
10. York Peninsula
11. Southern Lofty
12. Kangaroo Island
13. South-eastern



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NOTES ON *HIBBERTIA* (DILLENIACEAE) 3. *H. SERICEA* AND ASSOCIATED SPECIES

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Abstract

Twelve species and three subspecies are recognised, illustrated and keyed out. The new combination, ***H. platyphylla*** subsp. ***major***, is published for *H. sericea* var. *major* J.M.Black. The following new taxa are described: ***H. crinita, H. patens, H. platyphylla*** as well as its subsp. ***halmaturina, H. praemorsa, H. puberula, H. simulans, H. superans, H. tenuifolia*** and ***H. villifera***. *H. humifusa* is excluded.

Introduction

For most of a century only one species was recognised in this complex. The name, *H. sericea*, or *Pleurandra sericea* as originally described by de Candolle (1817) based on a specimen collected by Robert Brown near present Melbourne, was usually applied. Hooker (1835) described *Pleurandra densiflora*, and its combination *Hibbertia densiflora* was often used instead, as it was the first name for the species in *Hibbertia* (Kew Rule). Bentham (1863) adopted similar broad concepts as in the *H. aspera* group (Toelken 1998) in the *H. sericea* complex.

Black (1912, 1926, 1952) started a new evaluation of this group in South Australia and described in *H. sericea* a var. *major* with larger flowers, and var. *scabrifolia*, a 'scabrid-leaved' form. Of those the former is here recognised as a subspecies in *H. platyphylla* and the latter was reduced to synonomy within *H. sericea*. His *H. paeninsularis* (Black 1926, 1952), is still recognised as a localised species on southern Eyre Peninsula and western Kangaroo Island. The fact that Black (1952) also erroneously included *H. cinerea* as a variety of *H. sericea* based on their similar dense indumentum, shows the strong influence still imposed by Bentham's treatment on modern taxonomy. Black did not realise that this species should be placed in the *H. aspera* group (Toelken 1998).

The taxa, as in the *H. aspera* group, were here largely delimited on their morphology but usually their circumscription was supported by their specific geographical distribution. The complex itself is at present distinguished by the combination of a number of characteristics as enumerated above the key to the species. The following species were examined in this study: *H. crinita*, *H. paeninsularis*, *H. platyphylla*, *H. praemorsa*, *H. puberula*, *H. sericea*, *H. sessiliflora*, *H. simulans*, *H. superans*, *H. tenuifolia*, *H. villifera*. Although it may seem to be a natural group of species, its delimitation will become clearer once close groups, especially the *H. riparia - stricta* complex, has been revised. For instance, *H. humifusa* with very long stalked flowers and short fleshy bracts has here been excluded, although it agrees in a number of respects with the *H. sericea* complex. It had been revised in Toelken (1995) but its affinities are as yet not clear.

Characters

Habit

Plants of the *H. sericea* complex are usually shrubs with more or less woody branches, but as in most hibbertias the habit is rather plastic. Decumbent plants of, for instance, *H.*

paeninsularis were occasionally found rooting at the nodes, but no suckering plants as commonly found in the *H. riparia* complex have been observed in this group.

Vestiture

As in the *H. aspera* group (Toelken 1998) the different hair types are also useful in the classification of the *H. sericea* complex if examined over a large sample of the different organs of the species. They are therefore described here in a similar way.

All hairs have a tuberculate base but, unlike the *H. aspera* group, there are no basal cells with thickened walls arranged around them. A similar progression from simple to stellate hairs as Toelken (1998) reported for the latter group has also been observed in this group. Indications are, that, if other characters are equally considered, species with only simple hairs seem here to represent a different group, which possibly had developed in geograpical isolation, as the two groups now scarcely overlap. They do not necessarily represent the primitive group when compared to those with stellate hairs (cf. Affinities). Only in the case of *H. superans* and *H. crinita* do close affinities exist.

Leaves

The intrapetiolar or **axillary tufts of hairs** are particularly well developed immediately below flowers in this species complex, but the actual length varies considerably from one plant to another and according to conditions, so that it can not usually be used to distinguish between taxa. In some species the hairs remain a distinct tuft but in others they merge into the spreading simple hairs along the branches, as for instance in *H. sericea*.

In contrast to the *H. aspera* group, there are no distinct juvenile leaves except that the first leaves are more sparsely hairy and often the central vein is not as well developed. The cotyledons and hypocotyl of seedlings of *H. sericea* (*R.D. Hoogland 11869*, CANB) are glabrous, but everything above is more or less pubescent. A gradual acropetal change can be observed particularly below flowers as these leaves and branches are not only more densely hairy, but individual hairs tend to be longer (usually including the tufts in the axils of leaves). These upper leaves of some forms of *H. sericea* may become so densely hairy on both surfaces that they are indistinguishable from normal cauline leaves of *H. crinita*. When in doubt it is important to examine as many of the lowest leaves of all branches in order not to confuse the modified leaves below flowers with cauline leaves, as many of the latter may have been shed. The uppermost leaves modified in shape and/or size are for convenience referred to as hypsophylloids (cf. flowers).

The development of the central vein particularly of the cauline leaves of taxa of this complex is often characteristic in respect of its recessed/raised nature in relation to the revolute margins, and the length of the leaf for which it is visible on mature leaves. Young leaves on herbarium specimens are often misleading because the tissues of the central vein collapse, so that it can not usually be seen clearly how close it reaches to the apex of the leaf.

Environmental conditions may influence the size and shape of the leaves because the margins of the leaves recurve accordingly and this determines the amount of the undersurface visible. In some species the central vein is considerably broadened so that the undersurface is never visible as in the case of *H. platyphylla* subsp. *platyphylla,* while it is usually more or less visible in the other two subspecies. As a result of the strongly recurved margins of the leaves the adaxial surface covers much of the undersurface of the leaves. The vestiture of the leaves above and/or below are described thus irrespective of whether they are adaxial or abaxial in origin (cf. Toelken 1998). Similarly the revolute margins are not restricted to the original leaf margins but refer to that whole recurved part of the leaf.

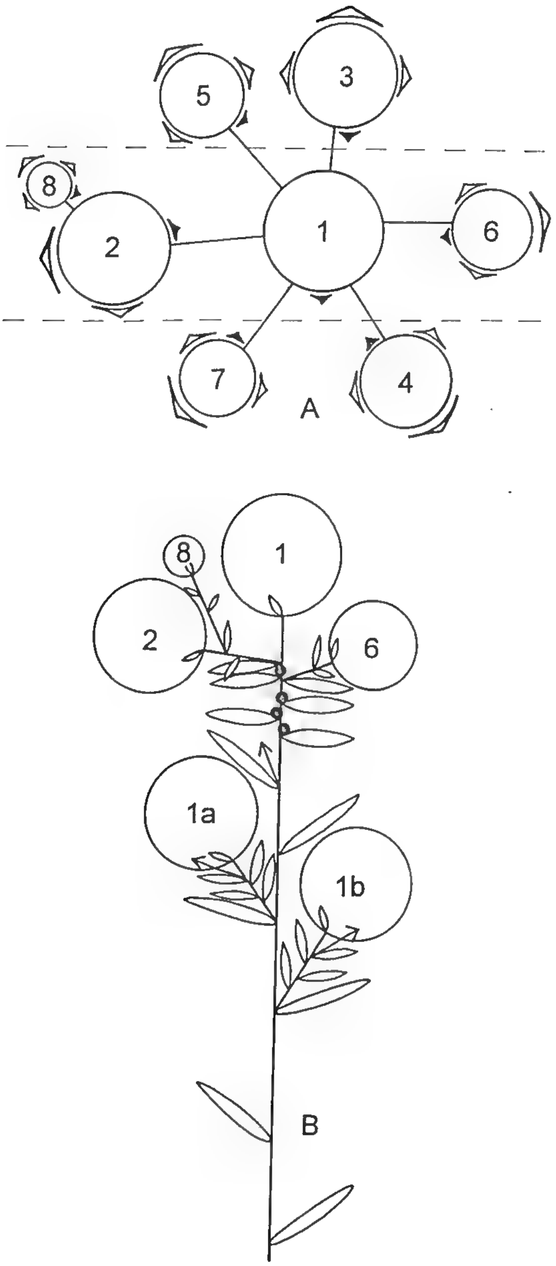


Fig. 1. ***H. villifera***. **A**, diagram of arrangement of flowers in a corymbiform polymonad seen from above. **B**, diagram of vertical section (cf. dotted lines in A) through terminal flower cluster with broad hypsophyloids, and upper branch with flowers terminal on short shoots from axils of linear-elliptic cauline leaves. br bract; h hypsophylloid; ● indicates the position of flowers omitted here; ↑ indicates likely positions of new growth flushes. (**A**, **B**, *H.R.Toelken 9177*, AD).

Flower arrangement

It is characteristic of the *H. sericea* complex that the terminal flowers are more or less hidden in the very densely clustered leaves at the apex of branches. A single terminal flower has been recorded in the species with only simple hairs, while there is usually more than one flower at the apex of branches in species with some stellate hairs, except in *H. sessiliflora* and *H. superans*. Fig. 11 (p. 46) of the latter shows the remains of the previous season's flower being overtopped by growth flushes from the axil of the first and second (or rarely the third but not in the example illustrated) leaf below the flower. This excludes the often leaf-like bract subtending the flower and which is not visible on the remains of the inflorescence because it is usually shed with the flower. In a good season the current terminal flower is soon similarly overtopped by vegetative growth, which will, however, terminate in a flower, often followed by another similar growth flush.

In *H. crinita*, a very similar species, comparable growth flushes produce terminal clusters of flowers because each of these flowers is derived usually in progressive basipetal succession from axils of the hypsophylloids below the terminal flower. Each new branch develops first 2 or 3 (rarely up to 5) reduced leaves and then ends in a terminal flower subtended by a bract, i.e. also here no growth was observed to develop from the axil of this last leaf below the flower. The flowers on the flower head of some forms of *H. crinita* are loosely arranged because of slightly elongated internodes between several leaves, while they are more or less sessile and below them on very short axes are two opposite leaves and a bract to the inside in *H. platyphylla*, *H. sericea* and *H. villifera* (fig.1A). The length of the prevailing favourable season will determine the number of flowers in terminal clusters. Sometimes seeds are shed from the first flowers while flower buds still develop on the periphery.

Since the terminal flower is always subtended by a usually leaf-like bract, the basic unit found here, as in most Hibbertias, is the **monad**, i.e. "an inflorescence ... consisting of a solitary flower together with its axis and the prophylls ... of the axis" (Briggs & Johnson 1979, p.244). Both internodes on either side of the bract are usually scarcely elongated so that the flower appears to be sessile in this complex. Under prolonged favourable conditions the inflorescence in *H. superans* is overtopped by repeated vegetative growth each with a terminal monad to form a **spiciform polymonad**. The dense terminal heads described for *H. villifera* (fig.1) are similar except that the whole of the inflorescence has been condensed into a **corymbiform polymonad**. The polymonads are mainly found in species with stellate hairs except for the occasional specimens of *H. paeninsularis* (cf. fig. 3), and they can often been observed in cultivated plants of that species. Other species with simple hairs are not known to have been cultivated.

This inflorescence seem to be derived from a thyrsoid similar to that found in *H. conspicua* (Western Australia) and a possible reduction is well visualised by the bracteate and extensively branched inflorescence of *Pachynema*, especially *P. junceum*, as analysed by Wagner (1906). Here too the main axis is terminated by a single flower, below which then branches (paraclades of first order) with up to 12 nodes without flowers before a terminal flower are formed. Each successive branch has fewer infertile nodes at the base until 2 remain in several species. Repeated branching (paraclades of the first, second, third etc order), each with this unusual feature of a single terminal flower, overtop the first flower (acrotonic ramification in Weberling 1965). This is reminiscent of the repeated branching in *H. superans* above, except that this usually little-branched inflorescence is distinctly foliose. The inflorescence of *Pachynema*, however, usually differs in two important aspects: firstly the leaf below the bract is often more or less displaced by recaulescence onto the branch which develops from its axil, and secondly occasional branching from the axil of the bract, more common in some species than in others, has been observed but it starts much later and shows a less vigorous growth than the axis subtended by the leaf below. Both these phenomena have never been observed in the *H. sericea* complex.

In most Hibbertias this monotelic inflorescence is reduced to flowers (monads) terminating most branches, and only in some species, and usually only under favourable conditions additional paraclades are produced. While some specimens of the form "Scabrifolia" of *H. sericea* develop only single terminal flowers, the similar species, *H. sessiliflora* produces only single terminal flowers commonly on short shoots along the branches, but the leaves subtending the flower are usually much reduced in contrast to single terminal flowers densely surrounded by large leaves in the species with simple hairs.

Although the first axillary bud develops usually from the first leaf below the bract there does not always seem to be a strict sequence in the development of subsequent growth flushes particularly once more than three branches (paraclades) have been established. The orientation of new axillary axes particularly of dense terminal polymonads seems to be determined by space, i.e. often the axillary bud of the second or third leaf in preference to the first one below the flower develops as it faces sideways (tangentially) or towards the outside. In larger terminal polymonads simultaneous growth from several of the lower leaf axils was observed so that some such branches might appear to be lateral short shoots with terminal flower/s (fig. 1B). Although such short shoots are rare in the *H. sericea* complex (except in *H. sessiliflora*, above) they are found in axils of cauline leaves below the dense hypsophylloids and are usually distinguishable by the shape the two types of leaves. Ultimately growth flushes from below them (fig.1B) show the individual units. Axillary branches have often only a single terminal flower (fig. 1B), but occasionally they too develop into few-flowered terminal polymonads.

In the *H. sericea* complex the bract below the flower has obvious revolute margins, is large and often similar in size to the subtending leaves or only slightly smaller to form a gradation into the often similar outer calyx lobes. The bract is always situated opposite the innermost calyx lobe and in front of the gap between the two carpels. Although the bract is often similar to the surrounding leaves it can be identified by its position and in the *H. sericea* complex it hugs the base of the flower while there is usually a short internode between it and individual leaves below. The calyx is basally connate so that the bract can be easily distinguished from the often similar outer calyx lobes.

In most species of the *H. sericea* complex the leaves below the flowering region usually become gradually modified from the cauline ones by increasing denseness (and frequently length) of the hairs, as well as, particularly in the stellate haired group, their shape and/or size. The last are here called for their obvious similarity **hypsophylloids**, because hypsophylls are according to modern definition part of an inflorescence (Briggs & Johnson 1979; Weberling 1989), but this is not easily delineated in *Hibbertia*. Hypsophylloids are a term of convenience and can often not easily be distinguished, because the hypsophylloids as the hypsophylls, usually show a gradation into normal cauline leaves.

Stamens

The number of stamens may vary considerably particularly in more widespread species such as *H. sericea* and *H. crinita*, but some variation has been recorded in all the species. The anthers are usually clumped between the upturned styles usually with the central one, or rarely a few anthers, longer. The filaments are more or less basally connate except in forms of *H. villifera*, where they are fused to just below the anthers.

Unusual are a few tufts of hair between the anthers and the respective petal as found in most of the species of this complex with stellate hairs, a feature not observed in other species of *Hibbertia* in eastern Australia.

Ovary

The style originates from the apex of the ovaries in species with an indumentum of simple hairs, while in most species with stellate as well as simple hairs the styles are more

or less laterally inserted into the ovary. The simple hairs of the ovaries of the former can usually only be recognised on fruiting ovaries, when they have much expanded.

Affinities

The species are at present listed alphabetically as a numbering system can only be established once all the species in the genus are known. This *H. sericea* complex is not as well defined as the *H. aspera* group and a clearer delineation will only emerge once the adjoining groups, especially the *H. riparia* complex, have been revised. All information available at present suggests a group of species with close affinities but too little agreement exists to assume monophyletic origin especially as the species can be grouped into four geographical complexes. Morphologically the species can be divided into those with simple hairs and others with at least some stellate hairs on the branches. Here, as in the *H. aspera* group (Toelken 1998), stellate hairs are considered derived from clustered simple ones as is clearly shown in the two closely related species *H. superans* and *H. crinita*. In contrast to the *H. aspera* group juvenile leaves of the *H. sericea* complex differ only by a usually slightly less dense indumentum from cauline leaves, which in turn are less densely hairy than the floral leaves, and some of them, the hypsophylloids, are different in shape and/or size, and only found in plants with stellate hairs. This restricted occurrence of hypsophylloids together with the high frequency of clusters of terminal flowers and the central vein of cauline leaves not reaching the apex of cauline leaves in the group with stellate hairs indicates that the following four complexes have at least for some time developed independently.

1. Species with only simple hairs (*H. paeninsularis*, *H. patens*, *H.praemorsa*, *H. puberula*, *H. simulans*, *H. tenuifolia*) mainly occur on or east of the Great Divide from north of Nowra to southern Queensland, the exception being *H. paeninsularis* from western South Australia (EP, KI). There are some records of *H. simulans* from the Western Slopes of New South Wales. They are often known only from restricted distribution areas.

It may be significant that simple hairs in the putative hybrid, *H. paeninsularis* × *H. villifera,* are dominant over stellate hairs, a suposedly advanced character. This strengthens the notion that group 1 represents an independent development which is further shown by the central vein of leaves continuing, although not always visible because of excessively recurved margins, to and usually more or less overtopping, the apex, which is then often tufted and recurved when young in contrast to those species with at least some stellate hairs on their branches.

2. Among the species with at least some stellate hairs on the branches *H. superans* and the often almost indistinguishable *H. crinita* occur largely in New South Wales, but also known usually from inland localities in Victoria and South Australia. Although *H. superans* has predominantly simple hairs and occurs east of the Great Divide, its central vein reaches to the leaf apex, but does not usually overtop it as in the previous group. The central vein only overtops the apex in the extreme form of *H. crinita* from the Flinders Ranges.

H. crinita is very similar to and often confused with *H. sericea* of the next group.

3. Species with mainly stellate hairs (*H. platyphylla*, *H. sericea*, *H. sessiliflora*, *H. villifera*) particularly on the undersurface of the leaves occur commonly in coastal south-eastern Australia. They are characterised by the presence hypsophylloids and their cauline leaves have a central vein, which does not reach the apex except in the case of the very much raised and broadened central vein of *H. platyphylla*. All the species have clustered flowers except *H. sessiliflora*, where the flowering branches are predominantly reduced to axillary short shoots with a single flower. The species is otherwise very similar to *H. sericea* and the rare Tasmanian *H. hirsuta*. Although the latter species has similar 'sessile' flowers on short shoots along the branches and the typical tufts of hairs in the leaf axils it has not been included. Its flat bracts without recurved margins and a central vein continued into the apex

of leaves as well as small flowers without tufts of hairs between the stamen/s and petals are usually characteristics of the *H. riparia* complex.

4. The *H. humifusa* complex from central Victoria also shares a number of characteristics with the *H. sericea* complex, but has not been included in the present paper, because a detailed account was published earlier (Toelken 1995). These plants look quite different because, in contrast to the terminal shoots with reduced internodes below flowers of *H. sericea*, their flowers are usually borne on an elongated flower stalk with internodes above and below the bract (anthopodium and propodium, cf. Conn 1995) usually elongated. They too produce flowers interspersed with vegetative growth (Toelken 1995, fig. 1D, E, F). This species has a slender central vein to the apex of leaves as well as some stellate hairs so that it does not fit into any of the above-mentioned groups of species. Although it has stellate hairs there are no tufts of hairs between the petals and the stamens in *H. humifusa*.

These and other minor morphological similarities mainly discussed under the individual species suggest the following developmental elaboration of the species of this complex for eventual numbering: *H. puberula*, *H. praemorsa*, *H. patens*, *H. simulans*, *H. tenuifolia*, *H. paeninsularis*, *H. superans*, *H. crinita*, *H. sericea*, *H. sessiliflora*, *H. villifera*, *H. platyphylla*, *H. humifusa*.

Taxonomy

The following combination of characters is here used to define the *H. sericea* complex:

1. A tuft of simple hairs, which elongates acropetally is found in the axil of leaves and is particularly long below the terminal flowers.
2. Simple hairs are often pronouncedly tubercle-based which resemble 'goose bumps' (but without base cells as in the *H. aspera* group).
3. Outer sepals and the bract subtending each flower have more or less recurved margins.
4. Bracts subtending the flowers are usually scarcely shorter than the leaves and have obvious recurved margins.
5. The floral region is vertically abbreviated so that not only the subterminal leaves and bracts but also often additional flowers develop in more or less tight terminal polymonads.
6. Few tufts of hairs are found between the anthers and petals.

Unlike the *H. aspera* group (Toelken 1998), the *H. sericea* complex is less well defined and has no unique characteristics. Only the first of the above characters is represented in all the species, but is also found, usually in a less well developed form in other species complexes, such as *H. cystiflora*, *H. riparia* and *H. vestita*. Until these have been investigated in similar detail this group of species is informally referred to as the *H. sericea* complex. The criteria for the inclusion of species in this paper are based on various combinations of the above characteristics as well as their apparent affinity to one another.

Although J.M. Black worked mainly from the herbarium specimens now in AD and on which he wrote various notes, it can from a few documented examples be assumed that duplicate specimens now housed in other herbaria, were sent there by Black to seek opinions from experts at other institutes on taxa he regarded as new. All of these specimens, irrespective of the presence of his annotations, or whether it is known that they were sent to other hebaria before or after publication of the new name, are regarded as part of Black's investigations of that taxon and are considered in the selection of lectotypes.

Key to the species and subspecies

1. Hairs all simple; terminal flowers single and surrounded by leaves similar to cauline leaves:
   2. Undersurface of leaves usually not exposed between revolute margins and central vein; long hairs up to 0.6 mm long; leaves puberulous to glabrescent;
      3. Ovary puberulous to glabrescent; leaves narrowly triangular .... ***H. puberula***
      3: Ovary villous or tomentose; leaves more or less linear:
         4. Outer calyx lobes not recurved and scarcely accrescent; ovary villous.......... ***H. simulans***
         4: Outer calyx lobes recurved and strongly accrescent; ovary tomentose .... ***H. tenuifolia***
   2: Undersurface of leaves usually exposed between revolute margins and central vein, or long hairs on leaves usually longer than 0.8 mm; leaves villous to appressed-pubescent;
      5. Leaves with more or less appressed hairs; South Australia (EP, KI).......... ***H. paeninsularis***
      5: Leaves with hairs spreading at ±90°; Queensland (Mo), New South Wales (ST, NC, CC):
         6. Leaves (2.4-) 3–4.5 (-7.6) mm broad; central vein not or scarcely raised .... ***H. praemorsa***
         6: Leaves 1.1–2.4 mm broad; central vein distinct (raised and/or broadened):
            7. Leaf apex more or less rounded and recurved; indumentum mainly of long hairs with a few shorter ones in between .... ***H. patens***
            7: Leaf apex acute becoming obtuse, erect; indumentum of velutinous layer of dense short hairs under few long ones.......... ***H. superans***

1: Hairs simple and stellate at least on branches; at least some terminal flowers in clusters of 1-5 (-15) and often surrounded by leaves different from cauline leaves (hypsophylloids):
   8. Central vein of cauline leaves not broadened and scarcely visible under stellate indumentum; leaf margins loosely recurved, not appressed.......... ***H. sessiliflora*** √
   8: Central vein of cauline leaves broadened at least in basal third and clearly demarcated whether with or without stellate indumentum; leaf margins revolute and usually appressed:
      9. Central vein of cauline leaves more or less confluent with apex:
         10. Cauline leaves with short indumentum (often under more or less long simple hairs) about equally dense below and above (especially on the margins):
            11. Hairs on branches and undersurface of leaves mainly stellate; ovary stellate-tomentose, with styles laterally attached; seeds broadly obovoid.......... ***H. crinita*** √
            11: Hairs on branches and undersurface of leaves simple with few stellate ones; ovary villous with simple hairs, with apical styles; seeds oblong-obovate to narrowly comma-shaped .... ***H. superans***
         10: Cauline leaves stellate-tomentose on undersurface but only or mainly simple hairs above:
            12. Cauline leaves with central vein reaching their apex but not confluent:
               13. Hypsophylloids with central vein not reaching the apex.......... ***H. villifera***
               13: Hypsophylloids with central vein confluent with the apex .... ***H. sericea*** √
            12: Cauline leaves with central vein more or less confluent with the apex.......... ***H. platyphylla***
               14. Branches without, rarely with few scattered long simple hairs below flowers; terminal flowers 1, or up to 3 but then in loose clusters .... ***H. platyphylla*** subsp. ***platyphylla***
               14: Branches more or less densely covered with long simple hairs; terminal flowers (1-) 2–5 (-15) in usually dense clusters:
                  15. Old cauline leaves straight and if recurved then from petiole; undersurface of cauline leaves not visible between revolute margins and central vein or if visible then leaves usually longer than 8 mm; Eyre and Yorke Peninsula.......... ***H. platyphylla*** subsp. ***major***
                  15: Old cauline leaves recurved along their whole length; undersurface of cauline leaves exposed between revolute margins and central vein; leaf length (2.2-) 3.6–7.5 (-11.4) mm; Kangaroo Island .... ***H. platyphylla*** subsp. ***halmaturina***
      9: Central vein of cauline leaves visible up to only 2/3 or just below apex and not confluent with apical margins:
         16. Central vein of cauline leaves visible for ca 2/3 of its length; styles yellow; simple hairs on upper leaf surface up to 0.8 mm long except for a few on revolute margins, coarse and usually without obvious tubercle.......... ***H. sericea*** √
         16: Central vein up to but not confluent with leaf apex; styles red; simple hairs on upper leaf surface up to 2 mm long, silky and usually arising from pronounced tubercles ('goose bumps') .... ***H. villifera***

H. crinita Toelken, *sp. nov.*

H. stricta (R.Br. ex DC.) F.Muell. var. *hirtiflora* Benth., Fl. Austral. 1: 27 (1863), partly as for "near Bathurst, *A.Cunningham*".

H. sericea auctt. non (R.Br. ex DC.) Benth.: Benth., Fl. Austral. 1: 26 (1863), partly; J.M.Black, Fl. S. Austral. 1 edn, 3: 386 (1926), partly; Ewart, Fl. Vict. 769 (1930), partly; J.M.Black, Fl. S. Austral. 2 edn, 3: 575 (1952), partly; N.C.W.Beadle et al., Fl. Sydney 1 edn, 196 (1963), partly; Willis, Handb. Pl. Vict. 2: (1973), partly; G.M.Cunningham et al., Pl. West. N.S.W. 498 (1981); N.C.W.Beadle et al., Fl. Sydney 3 edn, 228 (1982, partly; G.J.Harden & J.Everett in G.J.Harden, Fl. N.S.W. 1: 302(1990), partly.

H. stricta (R.Br. ex DC.) F.Muell. var. *canescens* auctt. non Benth.: J.M.Black, Trans. Proc. Roy. Soc. South Australia 43: 36 (1919); Fl. S. Austral. 1 edn, 3: 387 (1926); 2 edn, 3: 576 (1952); S.J.Forbes et al., Cens. Vasc. Pl. Vict. 48 (1984).

H. sericea Benth. var. *sericea sensu* S.W.L.Jacobs & J.Pickard, Pl. N. S. W. 110 (1981), partly.

H. densiflora auctt. non (Hook.)F.Muell.: F.Muell., Pl. Indig. Col. Vict. 1: 15 (1862), partly; Fragm. 7: 125 (1871), partly; Fragm. 11: 92 (1880), partly; Syst. Census 1 (1882), partly; Sec. Syst. Census 1(1889), partly; C.Moore & Betche, Handb. Fl. N.S.W. 10 (1893); Rodway, Tasm. Fl. 4 (1903), partly; Maiden & Betche, Census N.S.W. Pl. 139 (1916).

H. incana auct. non (Lindley)Toelken: Toelken, J. Adelaide Bot. Gard. 16: 64 (1995), partly; in Walsh & Entwisle, Fl. Vict. 3: 311 (1996), partly, as for specimens cited.

A *H. sericea* venis centralibus ad apicem foliorum caulinorum paginisque superis plerumque dense pubescentibus pilis stellatis; a *H. superanti* ovario velutino pilis stellatis, stylo plus minusve laterale, seminibus late obovoideis; a *H. incana* bracteis longis, lobis calycis obtusis vel rotundatis, partibus omnibus tectis aliquot pilis simplicibus differt.

Type: South Australia, summit of Mt Torrens, *N.N. Donner 3998*, 5.ix.1972 (holo.: AD; iso.: BRI; G; K; L; MEL; MO; NSW; NY; PERTH).

Shrubs 0.2–1.5 (-2) m tall, with few erect woody branches to wiry and much branched, villous to velutinous, the hairs rarely wearing off. *Vestiture* on all parts consisting of long silky simple hairs (0.3–2.2 mm long) over more or less dense short erect, usually stellate hairs, both slightly or not tubercle-based and becoming more dense acropetally; *on branches* with scattered or clustered simple hairs often wearing off on lower branches but below flowers distinctly longer than those of the tufts in the axils of leaves or rarely almost absent over dense and erect or sparse and multiangulate radially stellate hairs (3–7 subequal or unequally long branches) scarcely tubercle-based; *on cauline leaves above* with few to many long antrorse simple hairs mainly towards the margin, but often wearing off or increasing below the flowers over more or less dense erect or slightly antrorse short hairs mainly multiangulate stellate hairs (2–5 (-15) subequal branches); *on cauline leaves below* with more or less antrorse simple hairs along the revolute margins and the central vein over erect rarely radial multiangulate stellate hairs (5–15 (-25) subequal branches); *on hypsophylloids* similar to leaves but stellate hairs usually with fewer branches; *on outer calyx lobes* with few to many antrorsely inclined simple hairs on central vein to all over the outer surface over radial (rarely antrorse) multiangulate stellate hairs (3–15 (-many) usually very short subequal branches rarely pulvinate ones on the sides; *on inner calyx lobes* with few to no antrorsely inclined simple hairs mainly along the central vein over short radial to pulvinate multiangulate stellate hairs (many subequal branches) and usually with stellate margins. *Leaves* with axillary tufts of hairs elongating acropetally and rarely up to 1.8 mm long or rarely almost absent; *petiole* 0–0.6 mm long; *lamina of cauline leaves* linear to linear-lanceolate, linear-elliptic to rarely elliptic, (3.2-) 5.2–13.5 (-22.4) × (1.2-) 1.7–2.5 (-4) mm, usually abruptly constricted into petiole, acute to obtuse or rounded, with central vein often raised above and broader than the revolute margins (0.3–0.7(-0.85) mm wide in the middle) and visible to the leaf apex or protruding into apex, stellate-tomentose above and below, but often the undersurface not visible between the central vein and revolute margins, green or bluish-green fading to grey, rarely discolorous; *lamina of hypsophylloids* linear-lanceolate to ovate, (2.8-) 3.1–10 (-14.6) × 1.8–6 (-7.2) mm, usually abruptly constricted into petiole, gradually tapering into apex, similar to cauline leaves to broadly ovate, velutinous with or without long simple hairs. *Flowers* sessile or almost so, 1–6 (-8) in

usually corymbiform polymonads, often loosely arranged or younger overtopping older ones, subtended by few to many hypsophylloids, rarely none, terminal on main and often on short lateral branches; *bracts* like hypsophylloids subtending it. *Calyx* grey, pale to deeper green, often somewhat accrescent; *outer calyx lobes* oblong-lanceolate, lanceolate to rarely ovate, 5.3–11.7 × 1.3–2.2 (-2.6) mm, usually longer than inner ones, acute to rounded, with more or less recurved margins, outside villous to velutinous, inside one-third to almost

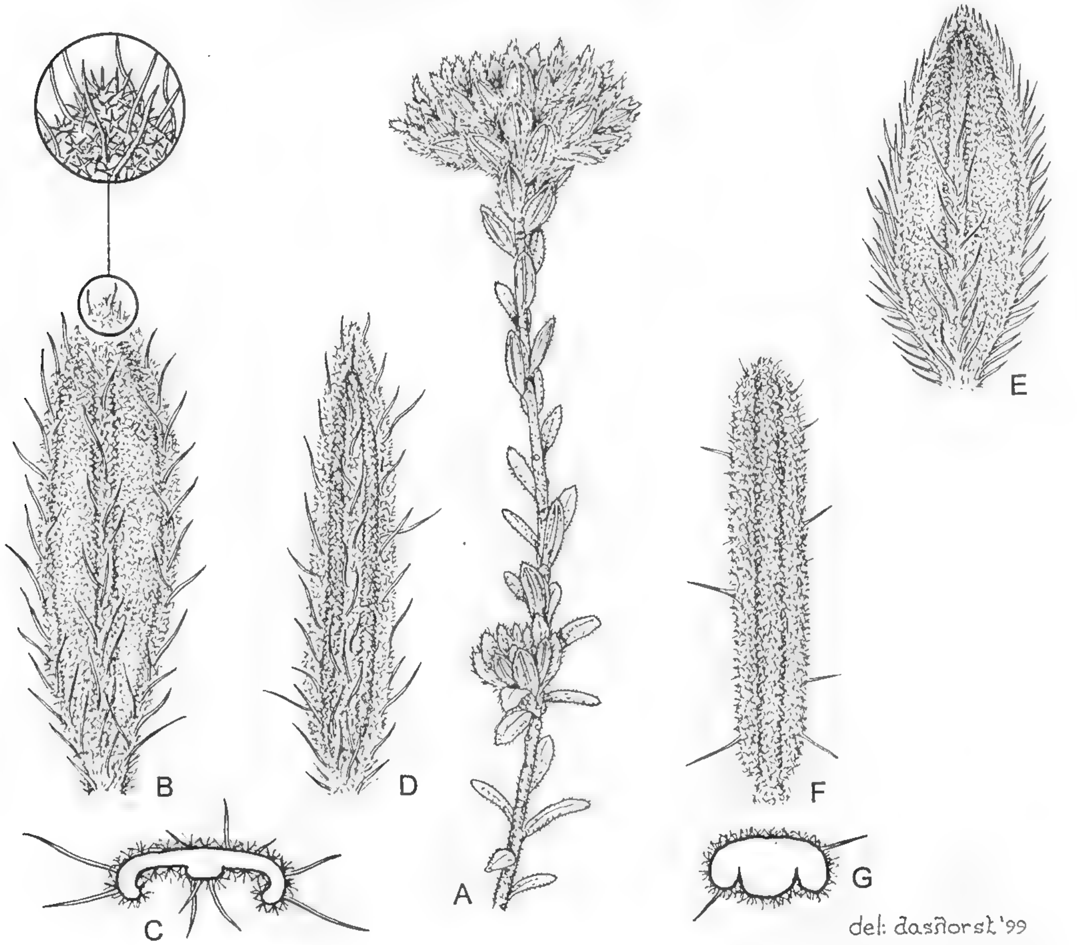


Fig. 2. ***H. crinita***. **A**, Flowering branch showing dense terminal flowers surrounded by hypsophylloids; **B**, flat cauline leaf; **C**, transverse section; **D**, cauline leaf with rolled margins; **E**, hypsophylloid showing narrow central vein; **F**, cauline leaf of Flinders Range's form with broad central vein continued into the apex; **G**, transverse section. (**A–E**, *D.E.Symon 275*, CANB; **F**, **G**, *Ising s.n.*, AD; **A** ×½; **B**, **D**, **E** ×6; **F** ×9; **G** ×18).

completely stellate-pubescent to tomentose or sericeous; *inner calyx lobes* ovate rarely obovate, 4.8–8.4 × 2.2–4.5 (-5.7) mm, rounded to cuspidate, outside stellate-tomentose rarely with few long simple hairs, inside often tomentose towards the upper margins. *Petals* obovate to broadly obovate, 5.4–13.6 (-15) mm long, emarginate to bilobed. *Stamens* (8-) 10–15 (-19) in one cluster with centrifugal ones usually shorter; *filaments* basally, rarely up to half connate, anthers linear, 1.6–1.8 (-2.1) mm long, dehiscing by terminal pores and lateral slits. *Pistils* 2, more or less laterally compressed, with 4–6 ovules, style base recurved along the apex of the ovary, then turned upwards on both sides and overtopping stamens, style greenish-yellow becoming more or less tinged red. *Fruit* stellate-tomentose.

Seeds pale to dark brown, ovoid to almost spherical, 1.8–2.1 × 1.8–2 mm, aril with fleshy base and scarcely lobed sheath surrounding and appressed to base of seed. *Flowering*: Aug.–Oct. Fig. 2A–G.

Distribution and ecology

Grows usually on sandy or gravelly soil derived from various geological formations, often associated with granite or sandstone, but has not been recorded from areas with surface limestone, and usually associated with dry woodland particularly Mallee in New South Wales (NWP, SWP, NWS, CWS, SWS, CT, ST), Victoria (LMAL, WIM, WAN, GR, MID, EHL, GPL, EG) and South Australia (FR, EA, EP. NL, MU, SL, KI, SE).

Conservation status. Widespread and locally common.

Diagnostic features

The combination of the characters, cauline leaves with a central vein visible to the apex, the presence of a more or less dense short (usually stellate) indumentum under longer simple hairs on the upper leaf surface, and inner surface of the outer calyx lobes usually being more than half covered with hairs distinguishes *H. crinita* from the very similar *H. sericea.* Usually the long central vein of cauline leaves suffices, but identification can be complicated when the leaf margins are tightly recurved. The base and generally the whole central vein of hypsophylloids of *H. crinita* remain relatively narrow in comparison to those of *H. sericea,* especially its form "Densiflora" which has often also a rather long central vein. The simple hairs of the latter form are also short and coarse in comparison to those of *H. crinita.*

Variation

Difficulties in distinguishing the two species may arise because of variation on the same plant. Juvenile leaves of *H. crinita* have very few stellate hairs on the upper surface so that it may be confused with normal cauline leaves of some of the more hairy forms, or at least the leaves below flowers, of *H. sericea* (cf. *H. sericea*: variation). Since the leaves below the flowers sometimes develop their dense indumentum early in both of these species, those of *H. sericea* may appear similar to cauline leaves of *H. crinita.* However, by looking at the whole range of variation on each plant one can compare leaves of similar position. In addition the central vein of *H. crinita* is always continued to the apex of cauline leaves. This is of particular importance in the case of older plants of *H. sericea*, which produce few or no typical cauline leaves between successive annual flower heads.

The genetic variation of *H. crinita* is exemplified in its extreme forms, none of which are distinguished here at infraspecific level because they do not show sufficient discontinuity in their expression. Some South Australian variation appears distinct because of the disjunct distribution of the species on mainly inland mountain ranges, but similarities, or a definite polarity of specific characters on both ends of the distributional gap, show incomplete discontinuity.

1. Erect plants with strikingly homogeneous velvety stellate indumentum under more or less long silky simple hairs on both leaf surfaces and branches had been distinguished under the name *H. stricta* var. *canescens* by Black (1926, 1952) for "Murray lands, Flinders Ranges" in South Australia. This variant with few or no simple hairs (Toelken 1995, p. 67) is here seen as belonging to a more widespread variation easily recognised by its erect stellate hairs (4–8 (-15) subequal branches) on the upper surface of cauline leaves. In South Australia it is usually associated with dry woodland or Mallee and is widespread, but only locally common in South Australia (FR, EA, EP, NL, MU, SL, KI) and Victoria (LMAL, GR) where it merges into main populations.

2. Similarly densely hairy (but usually much less so on the branches) variant of decumbent plants from south-eastern South Australia and adjoining Victoria that are densely covered with long simple hairs towards the apex of branches and especially on the calyx.

3. The most common plants of this species in the Mount Lofty region of South Australia have, as in what was named *H. sericea* var. *scabrifolia*, discolorous elliptic leaves (if not curled up) with the undersurfaces having radiating stellate hairs (8–18 (-25) subequal branches). The branches of this and the next variant tend to be sparsely covered with stellate hairs (4–6 often unequal branches) of various sizes. The type of the species belongs here.

4. While plants of the previous variant usually have single terminal flowers or rarely a few widely spaced ones, the plants of this more robust variation (bushes up to 1.5 m in diameter) have up to eight flowers in a terminal polymonads. Its linear leaves never show the undersurface, and the variant occurs only in a few localities on the southern Fleurieu Peninsula.

Typification

All parts of the type specimen of ***Pleurandra incana*** from Mt Hope in Victoria (MEL 35895) are covered only with radiating stellate hairs and the leaves have a raised broad central vein, which completely covers the gap of the undersurface of leaves. This combination of characters is sometimes observed in specimens from the Flinders Ranges in South Australia, but was not found in other specimens of *H. crinita* from Victoria, from where plants otherwise always have some simple hairs over the stellate indumentum. Neither are there any simple hairs on the calyx, or if present then few hooked simple hairs were observed on the outer calyx lobes. The latter, the pointed outer calyx lobes as well as the short bract subtending the flower refer *H. incana* to the *H. stricta* complex, although due to the absence of any other collections from the Mt Hope area, it could not be matched with other specimens. In comparing it with the form from the Flinders Ranges Toelken (1995) erroneously placed *H. incana* in the *H. sericea* complex.

H. stricta* var. *canescens Benth. is by implication based on *Pleurandra incana* because Bentham (1863) continued his discussion "In this I should include.." before citing other specimens. It must therefore be referred to the *H. stricta* complex and it is irrelevant that Bentham apparently had not seen either of the above type specimens. Black (1919) based his concept of this variety on *E.H.Ising s.n.* from "Mount Potawurta, near Moolooloo", but in 1926 he widened this delimitation to include specimens from the "Eastern States".

Notes

The widespread species, *H. crinita*, is similar to *H. sericea*, but unlike that species it occurs in drier woodlands mainly in inland localities of New South Wales, Victoria and South Australia. While *H. sericea* occurs mainly in coastal areas of Victoria, Tasmania and South Australia, the distribution of it and *H. crinita* overlap particularly in the Grampians (Victoria) and the southern Lofty Ranges (South Australia). Even here they were found in different habitats and never growing next to one another. These different distribution patterns are used here to show up the elements referred to by different authors under different names, because they usually did not annotate specimens to indicate their concepts. The synonymy can therefore only be broadly referred to.

The oldest specimen known of this species was collected by A.Cunningham (near the present Bathurst) on Oxley's Lachlan River Expedition in 1817. Bentham (1863) referred it to *H. stricta* var. *hirtiflora*.

The name *Pleurandra cinerea* is written on a number of sheets of *H. crinita* in F. Mueller's herbarium, indicating that he, followed by others, presumably considered these

species to be conspecific. Several of these specimens were collected by Mueller in his first year in Australia, e.g. MEL 35773 from Glen Osmond. In 1862 he cited *P. cinerea* in the synonomy of *H. densiflora* and in 1863 Bentham placed it under *H. sericea* but he also correctly referred to it under *H. billardierei* (cf. Toelken 1998). The latter two species are not even placed next to one another by Bentham, so that this confusion seem to have arisen merely because *H. crinita* and *H. cinerea* have a similar dense indumentum. Bentham also placed some specimens of *H. crinita* into *H. stricta* var. *canescens* and var. *hirtiflora* (cf. citations above) as they resemble densely hairy forms of that species complex. Mueller (1871; 1880) reinstated *H. densiflora* for this complex in favour of the inapt epithet "sericea" (see also Mueller, 1862), because it was the earlier name in *Hibbertia* (Kew Rule). During the following ca forty years this name was widely accepted for this species complex, and, it seems, some authors referred to it specimens here named *H. crinita*, because Bentham described his var. *densiflora* as "more villous". *H. densiflora* as used by Mueller (1882, 1889) refers to the whole *H. sericea* complex, as discussed there.

In South Australia Black (1926) was the first to recognise additional taxa and published *H. sericea* var. *cinerea*, which is excluded here as it was dealt with in the *H. aspera* group (Toelken 1998). Black's concept of *H. stricta* var. *canescens* was largely similar to the form from the Flinders Ranges but as he also referred to the "Eastern States" his delineation becomes obscure (see also typification).

Etymology

The epithet "*crinita*", Latin, " having tufts of long weak hairs" refers to the local tufts of long silky simple hair overtopping the short usually stellate indumentum.

Voucher specimens (ca 460 examined)

NEW SOUTH WALES: *J.D.Briggs 2287*, Newell Hway, 1 km S railway crossing at Alleena, 19.x.1987 (CANB, NSW); *R.D.Hoogland 12295*, ca 5 miles SW Schwagers Bore, 2.xi.1972 (CANB, MEL, NSW; A, BRI, K, L, P, n.v.); *M.M.Richardson 179 et al.*, 1km downstream from Burrinjuck Dam wall, 8.vi.1988 (CANB, NSW).

VICTORIA: *A.C.Beauglehole35377*, East Gippsland, Lambour Break, 11.xii.1970 (CANB, MEL); *R.D.Hoogland 11872*, ca 20 miles S Kaniva, 18.xi.1970 (AD, BRI, MEL; BISH, CANB, K, M, L, S, n.v.); *A.Meebold 21640*, Seymour, xi.1936 (AD, MEL, NSW).

SOUTH AUSTRALIA: *H.Eichler 15094*, Monarto South, 4.x.1958 AD, CANB); *R.D.Hoogland 11854*, Upper Hermitage, Mt Lofty Ranges, 13.xi.1970 (AD; A, CANB, K, L, n.v.).

H. paeninsularis J.M.Black, Trans. Proc. Roy. Soc. S. Austr. 49: 275 (1925); Fl. S. Austral. 1 edn, 3: 387 (1926); 2 edn, 3: 575 (1952); Jessop in Jessop & Toelken, Fl. S. Austral. 4 edn, 1: 355 (1986).

Type: South Australia, Coomunga, *J.M.Black s.n.*, 20.xi.1915 (holo.: AD 97037182; iso.: MEL 119767).

H. sericea auct. non (R.Br. ex DC.)Benth.: Tate, Handb. Fl. Extratrop. S. Austral. 24, 205 (1890), partly.

Low shrublets up to 25 cm high, with few to many decumbent branches, usually wiry-woody, rarely little branched, villous below the apices but glabrescent or glabrous below. *Vestiture* on all parts sparse to dense, more or less appressed, of fine simple hairs (up to 2.1 mm) often of equal length on the same organ except on inner calyx lobes with occasionally shorter hairs under longer ones, with basal tubercles often well developed towards the apex of leaves but hairs usually soon wear off. *Leaves* with axillary tuft of hairs elongating acropetally up to 1.7 mm long; *petiole* 0–0.3 (-0.4) mm long; *lamina of cauline leaves* and *hypsophylloids* similar except the latter tend to be larger, linear-lanceolate, (3.1-) 4.5–6.5 (-7.8) × 0.4–0.9 (-1.3) mm (or up to 9.3 mm long for hypsophylloids), scarcely tapering into petiole, pointed or acute and often with terminal tuft of hairs, with scarcely broadened, recessed (except broad and raised on first leaves on each branch and below each flowering

branch, i. e. prophylls) central vein (0.2–0.4(-0.5) mm broad at the middle), continued into the apex but often obscured by strongly revolute margins, undersurface not visible, sericeous to villous on both surfaces but soon wearing off, usually grey-green turning reddish-brown. *Flowers* sessile, single, rarely in spiciform polymonads, subtended by few to many hypsophylloids, terminal on long and short shoots, with new growth from between hypsophylloids or below; *bracts* linear to linear-lanceolate, 4.3–8.6 mm, similar to hypsophylloids, with strongly recurved margins covering more or less of the central vein, villous. *Calyx* grey-green, rarely tinged red when flowering; *outer calyx lobes* lanceolate to ovate, (4.5-) 5–6.5(-7.1) × 1.3– 1.6 mm, acute to acuminate and often accentuated by terminal tuft of hairs, villous, inside upper third pubescent with appressed simple hairs; *inner calyx lobes* broadly ovate, rarely oblong-ovate, (4.4-) 5–6.2 (-6.8) × 2.1–2.8 mm, obtuse to acute, or mucronate, villous centrally, sericeous and appressed laterally. *Petals*

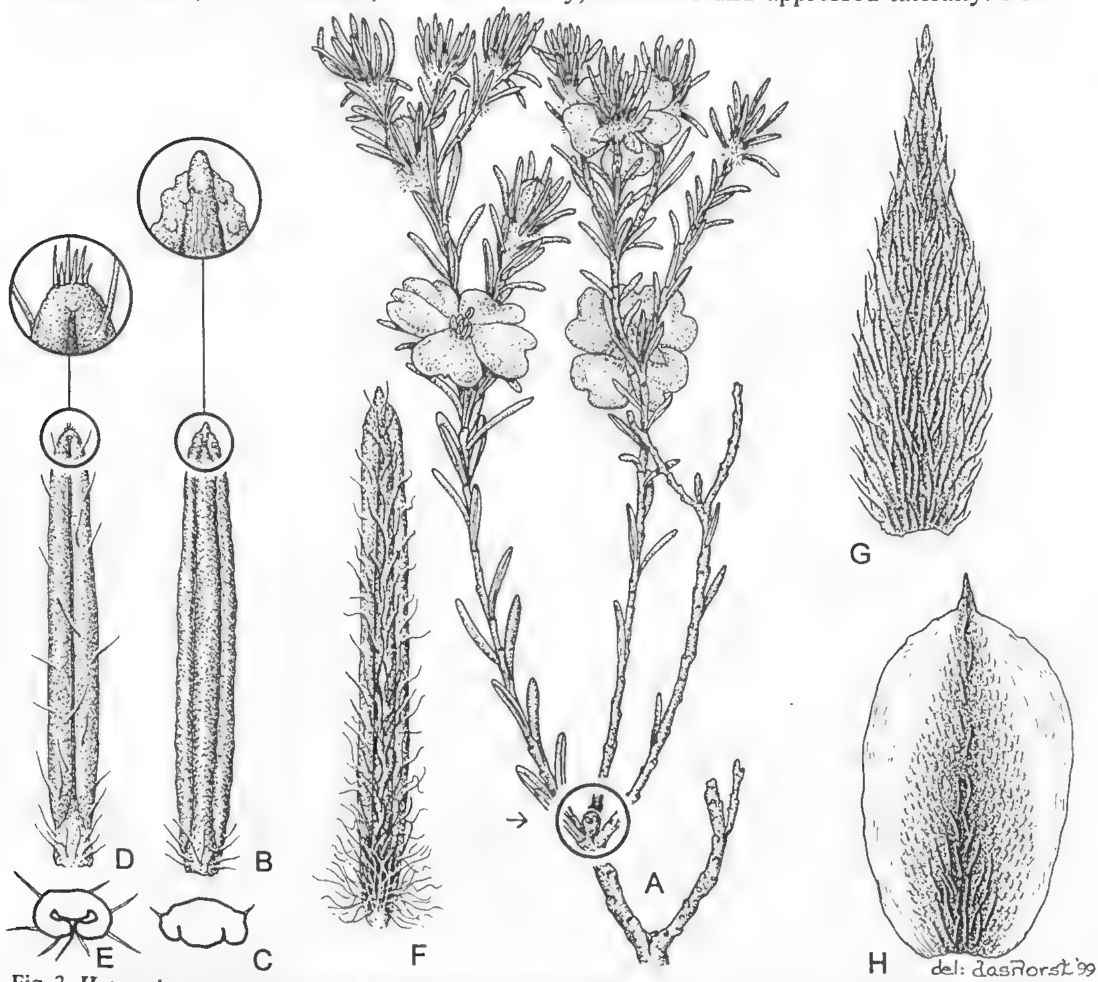


Fig. 3. *H. paeninsularis*. **A**, flowering branch showing scar of flower from previous year and overtopping flowers within the same year; **B**, cauline leaf with raised central vein prevalent, ason Kangaroo Island; **C**, transverse section; **D**, cauline leaves with recessed central vein and rolled margins common on Eyre Peninsula; **E**, transverse section; **F**, bract; **G**, outer calyx lobe; **H**, inner calyx lobe. (**A**, **D–H**, *J.D.Briggs1248*, AD; **B**, **C**, *B.M.Overton 2586*, AD; **A** ×½; **B**, **D**, **F** ×10; **C**, **E** ×15; **G**, **H** ×14).

obovate to broadly obovate, (6.8-) 7.5–9.5 (-11.4) mm long, more or less bilobed. *Stamens* 6–8, with filaments basally to half connate; anthers oblong, 1.4–1.5 mm long, subequal, dehiscing by terminal pore and lateral slit. *Pistils* 2, scarcely compressed, with 6 ovules,

style base scarcely recurved along apex of villous rarely tomentose ovary; styles yellow. *Fruit* simple-villous. *Seeds* brown to probably shiny-black, ca 1.6 × 1.6 mm, aril with a fleshy base surrounded by scarcely lobed fleshy sheath covering lower quarter to third of seed. *Flowering*: Sept.–Nov., but also in May. *Common name*: Peninsula guinea-flower (Jessop 1986). Fig. 3A–H.

Distribution and ecology

Grows on sand, sandy clay, often lateritic clay with or without ironstone, and often associated with wet depressions or drainage lines in open forest to woodland and sometimes common in or next to cleared areas; endemic to South Australia (southern, rarely central EP, mainly western and central KI).

Conservation status: Locally common and conserved in several conservation parks and Heritage Agreement areas on Eyre Peninsula and Kangaroo Island. 3RCa (Davies 1992; Briggs 1996).

Diagnostic features

Like all the species in the *H. sericea* complex *H. paeninsularis* has pronounced axillary hairs which become even longer acropetally, but differs from all southern species by the presence of only simple hairs on all parts of the plant, a decumbent to almost prostrate habit, and single terminal flowers which are never borne in clusters but often, especially in cultivation, overtop one another as part of proliferation as described earlier.

Variation

The leaves of *H. paeninsularis* like those of *H. sessiliflora* roll tightly and no specimen, alive or dried, has been seen in which the undersurface was exposed. The apex or much of the central vein is often obscured by the strongly revolute margins in plants from the Eyre Peninsula, so that its continuation into the apex is rarely visible. In contrast most collections from Kangaroo Island have the central vein broadened and raised to the level of the revolute margins, so that they are usually visible into the apex of the leaf, or at least on the shorter prophylls. In some leaves parts of the undersurface may become exposed (cf. Davies 1986) but this is rare. The two forms are usually distinguishable irrespective of the amount of rolling of the leaves due to environmental conditions. Although the leaves of the former tend to be narrower, these characteristics of the two geographic forms showed few intermediates but were never found to be consistently linked to other characters as in *H. platyphylla* subsp. *halmaturina* (see also hybrid below).

The flowers and in particular the calyx lobes are very variable in size sometimes even on the same plant.

Notes

Two specimens of this species were collected on 28.ii.1886 by J.G.O.Tepper between "Cygnet [River] to Ravine [des Casoars]", but presumably because they had no flowers the species was described only about forty years later. These specimens (AD 97828175, 97828197) were not identified but a similar Tate specimen (AD 97620423) from Port Lincoln was inscribed *H. sericea.* These three specimens probably form the basis for Tate's (1890) records of *H. sericea* from these two regions, and may be his reason for "outer sepals somewhat silky", which is usually not the case in what Black (1925) described as the var. *scabrifolia*, the most common form of that species in South Australia.

Voucher specimens (61 examined)

SOUTH AUSTRALIA: *J.D.Briggs 1200*, 15 km N Port Lincoln, 17.ix.1983 (AD, CANB, MEL, P); *R.J.-P.Davies 636*, 1.5 km W of NE corner of Yeldulnie Conservation Park, 25.v.1992 (AD); *P.Martensz 328*, Kangaroo Island, 3.x.1970 (AD, CANB, K, L); *B.M.Overton 1123*, intersection of Birchmore Road and Playford Highway, 7.xii.1989 (AD).

Putative hybrid

H. paeninsularis* × *H. villifera

This plant stood out among others of *H. paeninsularis* because of its relatively long branches with long internodes throughout, central vein strongly recessed, sometimes with terminal polymonadsof few flowers, and the presence of short simple hairs under long ones on the branches, all characters also found in *H. villifera*. The plant had a decumbent habit, short leaves, and only simple hairs reminiscent of *H. paeninsularis*.

The dominance of only simple hairs an all parts of the plant is an interesting feature of this putative hybrid.

Specimens examined

SOUTH AUSTRALIA: *H.R.Toelken 9233*, ca 1 km E Kelly Hill, 17.x.1997 (58% abnormal pollen; plant with abnormal growth); *H.R.Toelken 9235*, ca 1 km E Kelly Hill, 17.x.1997 (37 % abnormal pollen; almost typical habit);

H. villifera

SOUTH AUSTRALIA: *H.R.Toelken 9225*, Lower Church Road NW of Kelly Hill, 16.x.1997 (5% abnormal pollen); *9238*, Southern Highway, 14.4 km E Kelly Hill, 17.x.1997 (2% abnormal pollen); *9242*, Kingscote to American River, 17.x.1997 (4% abnomal pollen).

H. paeninsularis

SOUTH AUSTRALIA: *P.Martensz 328*, Kangaroo Island, 3.x.1970 (1% abnormal pollen); *H.R.Toelken 9232*, ca 1 km E Kelly Hill, 17.x.1997 (6 % abnormal pollen).

H. patens Toelken, *sp. nov.*

H. sericea auctt. non (R.Br. ex DC.) Benth.: C.T.White, Proc. Roy. Soc. Queensl. 47: 51 (1936); N.C.W.Beadle, Stud. Fl. NE N.S.W. 3: 255 (1976), partly; Stanley in Stanley & E.M.Ross, Fl. SE Queensl. 1: 189 (1983); G.J.Harden & J.Everett in G.J.Harden, Fl. N.S.W. 1: 302(1990), partly; S.T.Reynolds, Queensl. Vasc. Pl. 100 (1994); Queensl. Pl. 65 (1997), partly.

A *H. sericea* pilis simplicibus partibus omnibus et costa centrali angusta foliorum confluenti margine apicale; a *H. simulanti* pilis sericeis longis et costa centrali foliorum angustiore quam petiolo differt.

Type: Queensland, Mt Maroon, *I.R.Telford 3541*, 4.x.1973 (holo.: CANB; iso.: A, L, n.v.).

Shrubs 0.6–1m tall, usually much branched and with several branches from the base, villous. *Vestiture* on all parts consisting of a mixture of long and short spreading simple hairs, both more or less prominently tubercle-based particularly on leaves and spreading at ca 90° unless restricted and on the calyx lobes antrorse. *Leaves* with axillary tuft of hairs elongating acropetally to 1.8 mm long; *petiole* 0.4–1.4 mm long: *lamina of cauline leaves and hypsophylloids* linear to oblong-oblanceolate or -elliptic, (3.5-) 4.5–11.8 (-15.4) × 1.1–2.4 mm, obtuse or if pointed then apex somewhat recurved, gradually constricted into petiole, distinct central vein usually raised to level of recurved margins and continued (0.2–0.35 (-4) mm wide in the middle) into tufted recurved apex, villous, with undersurface usually visible. *Flowers* single, terminal commonly on main branches; *bracts* linear-oblanceolate, 4.8–12.2 × 1.8–2.2 mm, leaf-like, villous to appressed-pubescent. *Calyx* more or less accrescent; *outer calyx lobes* oblong-lanceolate, pointed to acuminate with slightly recurved margins, 5.4–12.3 × 2.2–3.5 mm, outside villous to appressed-pubescent, inside

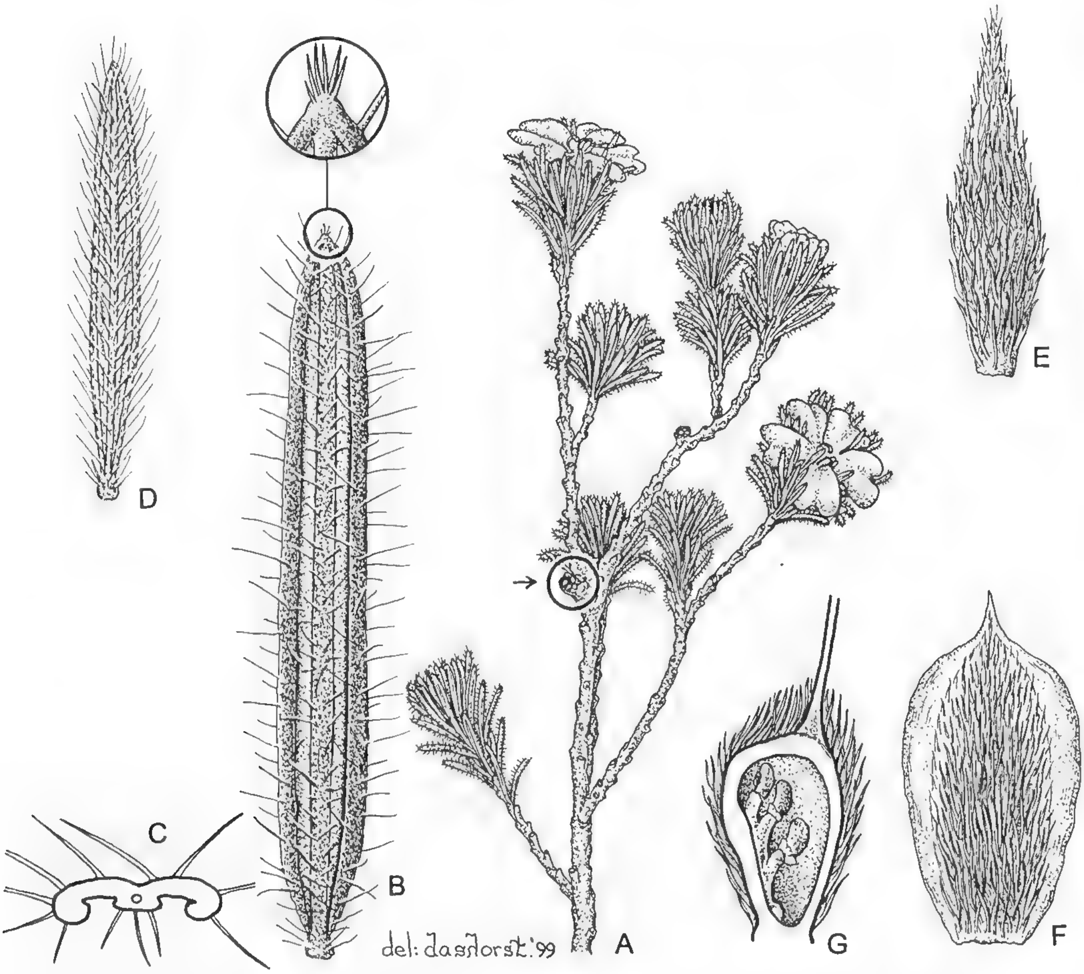


Fig. 4. ***H. patens***. **A**, flowering branch; **B**, cauline leaf; **C**, transverse section; **D**, bract; **E**, outer calyx lobe; **F**, inner calyx lobe; **G**, half pistil with terminal style from ovary with simple hairs. (**A–D**, *I.R.Telford 3541*, CANB; **E–G**, *E.F.Constable NSW24044*; **A** ×½; **B, D, F**, ×10; **C** ×20; **E** ×6; **F** ×4; **G** ×12).

one-third to two-thirds covered with appressed silky hairs; *inner calyx lobes* oblong-elliptic to -lanceolate, acute or pointed by folding, 5.3–11.8 × 2.3–3.7 mm, outside villous to appressed-pubescent along the central vein becoming pubescent towards the margins, inside with appressed hairs towards the apex. *Petals* obovate, 5.6–13.7 mm long, rounded to slightly emarginate; axillary tuft absent. *Stamens* 12–26, subequal; filaments scarcely basally connate; anthers narrowly oblong, 1.8–2.6 mm long, dehiscing by terminal pore and lateral slits. *Pistils* 2, each ovoid, with 4–6 ovules; style from apex, erect in front of clustered stamens. *Fruit* villous with simple hairs. *Seeds* not seen. *Flowering*: Mainly Aug.–Nov., but also one record from March. Fig. 4A–G.

Distribution and ecology

Grows usually in rock crevices at altitudes of more than 600 m on Mt Ernest, Mt Maroon and Mt Barney in south-western Queensland (MO).

Conservation status. The three main localities are conserved but no population studies are available. 2RC.

Diagnostic feature

The long silky simple hairs which spread at about right angles from their base are characteristic of this species, as are the long axillary hair tufts, the terminal leaves clustered around a flower, and the exposed undersurface of the leaves. Unlike *H. sericea*, *H. patens* is distinguished by having only simple hairs, the central vein is visible to the apex of cauline leaves, which are similar to the leaves clustered around the flowers (i.e. hypsophylloids are not distinguishable), and the absence of a tuft of hairs between the stamens and petals. *H. patens* is also distinct from *H. simulans* by its silky simple hairs on both sides of the leaves, the undersurface is more or less visible on most leaves, and the distinct central vein is scarcely broadened, viz. narrower than the petiole.

Variation

Although this species has been recorded from separate populations at altitudes above 600 m on different mountains (Stanley 1983) it seems to be a genetically homogeneous entity as is indicated by the fact that the described range of variation in the size of the different organs was found covered by two extreme specimens collected on Mt Barney (robust form: *E.F.Constable NSW 24044*; depauperate form: *S.L.Everist 1375*, BRI).

Notes

Although leaves below the flowers often seem to be different and especially more densely hairy this is here often not the case because these silky hairs quickly wear off, as can particularly be seen with the apical tufts. At times the central vein of these leaves appears more pronounced and hypsophylloids cannot in this species be distinguished. The terminal clusters of leaves were found to contain only one flower in contrast to the clusters in *H. sericea*, but in a few cases another flower occurs on a short branch below. Since one cannot distinguish hypsophylloids it cannot be evaluated from herbarium material whether this flower is part of a terminal cluster (cf. flowering leaves) or a short branchlet with a terminal flower.

Etymology

This distinct species is covered by characteristic long and short soft hairs spreading at about right angles, which is captured in the epithet "*patens*", Latin, "spreading, diverging from the axis at almost 90°".

Specimens examined (8 examined)

QUEENSLAND: *E.F.Constable 3850* (BRI, NSW); *S.L.Everist 1375*, Mt Barney, 13.x.1935 (BRI); *G.Leiper s.n.*(AQ458082), Mt Ernest, 11.ix.1989 (BRI); *N.Michael 2223*, Mt Lindesay, 14.vii.1935 (BRI); *L.S.Smith s.n.*, Mt Maroon, s.d. (BRI); *C.T.White 7852*, Mt Barney, 27.viii.1931 (BRI); *86591*, Mt Ernest, 10.x.1932 (BRI)

H. platyphylla Toelken, *sp. nov.*

H. stricta auct. non (R.Br. ex DC.)F.Muell.: Tate, Handb. Fl. Extratrop. S. Austral. 24, 205 (1890), partly.

H. sericea auct. non (R.Br. ex DC.)Benth.: J.M.Black, Fl. S. Austral. 1 edn, 3: 387 (1926), partly; 2 edn, 3: 576 (1952), partly.

A *H. sericea* costa centrali foliorum caulinorum confluenti margine apicali, hypsophylloidibus latis, 1 rare 3 floribus terminalibus; a *H. stricta* var. *glabriuscula* hypsophylloidibus latis exponentibus paginis abaxilaribus, costa centrali plerumque recessa, presentia frequenti pilorum simplicium differt.

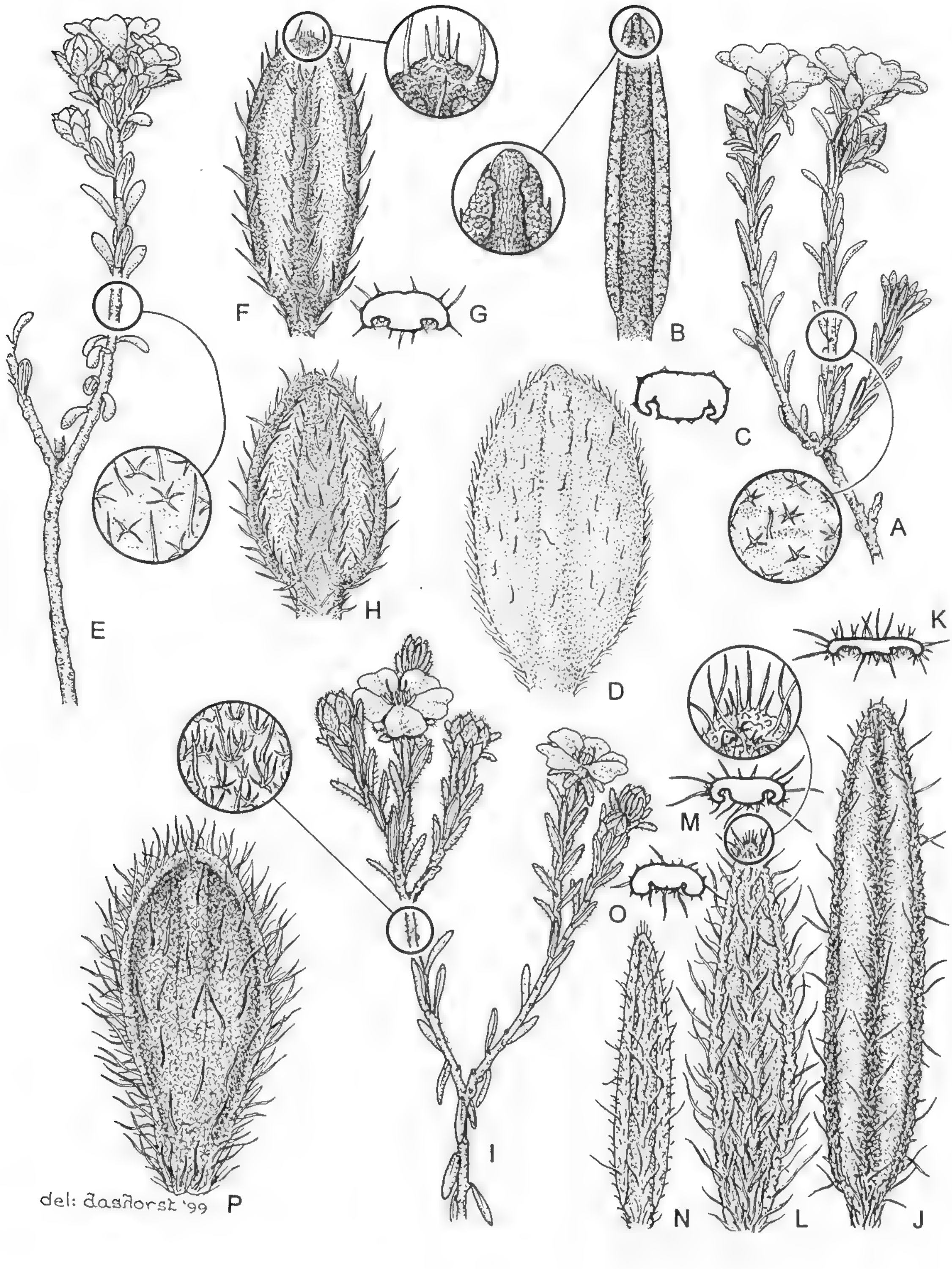
Type: South Australia, *H.R.Toelken 8565*, 0.5 km S of intersection, along Foul Bay Road, 1.x.1994 (holo.: AD; iso.: CANB, G, K, MO, NSW, PERTH, S).

Shrubs 0.3–1 (-1.5) m tall, with many stems and wiry branches to few stems with woody branches, often becoming densely branched, villous, pubescent to puberulous. *Vestiture* on

all plants consisting of simple hairs (0.2–1.8 mm long) but sometimes few over small stellate hairs, both more or less tubercle-based and becoming denser acropetally; *on branches* with many to sometimes few scattered simple hairs often wearing off on lower branches, below flowers often of similar length to the tufts in the axils of leaves so that these tufts appear to spread laterally (but not along the decurrent leaf bases), over multiangulate hairs of two sizes, the few to absent larger erect ones (1–3 often unequal branches) over usually many smaller, often depressed or pulvinate ones (3–6(-8) usually subequal branches) increasing in number and size acropetally (5–8 (-22) often antrorse subequal branches); *on leaves above* with antrorse simple hairs becoming longer towards the margins, many to often few and wearing off, over acropetally increasing and antrorse to radial stellate hairs (1–5 subequal branches); *on leaves below* with scattered simple hairs along margins and central vein (rarely completely absent) over multiangulate or erect stellate hairs (3–5 often unequal branches) to dense ones((8-) 10–20 (-26) subequal branches) on the undersurface if visible: *on hypsophylloids* above with few to many antrorsely inflexed to appressed simple hairs over usually antrorse stellate (rarely radial) stellate hairs, below with few to many antrorsely curved hairs over mainly dense multiangulate stellate hairs; *outer calyx lobes* with many to few antrorsely inclined and curved, often coarse simple hairs, over antrorse (rarely radial) multiangulate stellate hairs (3–8 often unequal branches) to erect but pulvinate ones (5–10 or more often unequal branches) towards the sides; *on inner calyx lobes* sometimes with few simple hairs mainly along the central vein over short pulvinate stellate hairs (many very short subequal branches), and usually stellate-ciliate margins. *Leaves* with axillary tuft of hairs more or less elongating acropetally to 1.6 mm long, but usually much shorter; *petiole* (0.2-) 0.8–1.5 mm long; *lamina of cauline leaves* linear, linear-elliptic or -oblanceolate, rarely oblong-lanceolate, (3.6-) 6–16 (-26.4) × 1.1–3.5 (-4.8) mm, obtuse to rounded, more or less abruptly constricted into petiole, with broad central vein continued into apex and varying from little broader to slightly thinner (0.4–0.6 (-0.8) mm wide at the middle) than, and usually only up to about as thick as, revolute margins, above scabrid to pubescent or glabrous, undersurface if visible (cf. subspecies) then tomentose; *lamina of hypsophylloids* elliptic to obovate, rarely ovate or oblong-ovate, 2.2–4.3 (-18.4) × (1.2-) 2.5–5.5 (-6.2) mm, rounded, rarely obtuse, with recurved margins often much reduced, scarcely raised central vein often only visible in upper third, widely exposed undersurface strigose- to stellate-tomentose. *Flowers* sessile to stalked (up to 8 mm long and subtended by few often caducous hypsophylloids), 1–5 (-16) in dense or loose corymbiform polymonads, terminal on main branches, rarely on subterminal short shoots; *bracts* lanceolate, elliptic or oblanceolate, (1.2-) 2.5–6 (-10.6) × 1.3–3.5 mm, flat to more or less cymbiform with central vein scarcely raised, tomentose, pubescent to almost glabrous. *Calyx* green tinged red to purple, more or less accrescent; *outer calyx lobes* ovate and acute, 4.8– 8.5 (-13.8)× 2.6–4.3 (-5.2) mm, acute to cuspidate, outside hispid, villous to almost glabrous, inside sericeous, with few simple hairs over stellate ones on much of the surface; *inner calyx lobes* oblong-ovate to almost orbicular, 3.7– 8 (-12.3) × 3.9–5.5 (-6.3) mm, obtuse, rounded to emarginate, coarse-sericeous along the central ridge to stellate-tomentose towards the ciliate margins. *Petals* broadly obovate to obcordate, 6.6–11.9 (-15.2) mm long, broadly bilobed. *Stamens* 10–15 (-22), subequal; filaments basally connate; anther oblong, 1.8–2.1 (-2.6) mm long, dehiscing by terminal pore and lateral slits. *Pistils* 2, laterally compressed, with (4-) 6 ovule; style with base recurved along the apex of each ovary, then curved upwards around the clustered stamens, yellow to yellowish-green. *Fruit* stellate-tomentose. *Seed* brown to shiny black, almost spherical, ca 2.3 × 2.2 mm, aril a fleshy ring basally expanding into scarcely lobed surrounding sheath appressed to lower third of seed.

Diagnostic features

Cauline leaves of *H. platyphylla* have a broad central vein which extends to the apex of the leaves and is there more or less obviously confluent with the revolute margins. The arrangement of the flowers often seems rather similar to that of *H. stricta* var. *glabriuscula*,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and, since it has often similar tightly rolled leaves it is not surprising that many specimens have been identified as such. *H. platyphylla*, however, usually produces tufts of hairs in the axils particularly of the upper leaves and also has a few hairs between the petals and stamens (not always present), and the undersurface of the leaves is often slightly visible between the central vein and the revolute margins in at least all the leaves of subsp. *halmaturina*. These are all characteristics of the *H. sericea* complex.

Variation

The three subspecies are not always easily identified as some local populations show intermediate characteristics of some characters and only by the use of others they can be separated. The subsp. *major* is particularly rich in local variation which is often restricted to isolated mountain ranges on Eyre Peninsula. The hypsophylloids often seem characteristic but their shape and size varies considerably. Differences in the size of the calyx seem to be due to local variation in the degrees of their accrescence. Among the many variations found in this species particularly on Yorke Peninsula the hairs on the branches were found the most reliable character to distinguish between the two mainland forms. Only the subsp. *halmaturina* is found on the nearby Kangaroo Island and it is remarkably uniform in producing cauline leaves recurving with age and in having an exposed undersurface. Both subspp. *major* and *halmaturina* have many simple hairs on their stems although in the latter they tend to be shorter and more like those of subsp. *platyphylla*. As this characteristic could not be linked with any others, because even the stalked flowers of the typical variety are occasionally found in subsp. *major*, the three entities are treated as subspecies. The long simple hairs on leaves typical of subsp. *major* are usually, unlike those of *H. villifera* and *H. paeninsularis*, not distinctly longer towards the petiole although they usually become more frequent. However, because the hairs towards the apex of the leaves wear off much more quickly, those at the base may appear to be longer.

Notes

Stellate hairs on the branches and especially on the inner calyx lobes are often depressed or erect but with very short branches (pulvinate).

Etymology

Specimens of this species were often confused with the very variable *H. stricta* var. *glabriuscula* because, similar to that species, the bold central vein continues into the leaf apex of at least the typical subspecies. The epithet "*platyphylla*", Greek, "*platys*" "broad or flat" and "*phylla*" "leaves", refers to its relatively broad and flat leaves with more or less recessed central vein in contrast to those of *H. stricta* var. *glabriuscula*, where the central vein is raised above the revolute margins.

a. subsp. **platyphylla.**

H. stricta (R.Br. ex DC.)F.Muell. var. *hirtiflora* Benth., Fl. Austral. 1: 27 (1863), partly as for specimens "from Spencer Gulf" and "Streaky Bay".

H. sericea (R.Br. ex DC.) Benth. var. *scabrifolia* J.M.Black, Trans. Proc. Roy. Soc. South Australia 49: 278 (1925), partly, as for "Streaky Bay".

Fig. 5. ***H. platyphylla*** subsp. ***platyphylla***. **A**, flowering branch with scar of previous flowers below; **B**, cauline leaf with undersurface not visible; **C**, transverse section; **D**, hypsophylloid/ bract. – subsp. ***halmaturina***. **E**, flowering branch showing recurved old leaves; **F**, cauline leaf; **G**, transverse section; **H**, hypsophylloid/ bract. – subsp. **major**. **I**, flowering branch; **J**, flat cauline leaf of typical form; **K**, transverse section; **L**, flat cauline leaf of common form; **M**, transverse section; **N**, cauline leaf with rolled margins of common form; **O**, transverse section; **P**, hypsophylloid/ bract. (**A–D**, *H.Eichler 14086*, AD; **E–H**, *H.Eichler 15538*, AD; **I**, **M–P**, *R.J.Bates 7925*, AD; **J,K**, *C.R.Alcock AD98827192*; **A, E. I** ×½; **B, G** ×6; **C, D, N, P** ×10; **F, H, L, M** ×7; **J, K** ×4; **O** ×15).

H. stricta auctt. non (R.Br. ex DC.)F.Muell.: Tepper, Trans. Proc. Roy. Soc. South Australia 3: 34 (1880); Tate, Trans. Proc. Roy. Soc. South Australia 12: 70 (1889); Handb. Fl. Extratrop. S. Austral. pp. 24, 205 (1890), partly; Trans. Proc. Roy. Soc. South Australia 13: 116 (1890), partly.

H. stricta var. *glabriuscula auct. non* J.M.Black; J.M.Black, Fl. S. Austral. 1 edn, 3: 387 (1926), partly; 2 edn, 3: 576 (1952), partly.

H. sericea auct. non (R.Br. ex DC.)Benth.: J.M.Black, Fl. S. Austral. 1 edn, 3: 387 (1926), partly; 2 edn, 3: 576 (1952), partly.

H. sericea (R. Br. ex DC.)Benth. var. *major auct. non* J.M.Black: Jessop in Jessop & Toelken, Fl. S. Austral. 1: 358 (1986), partly.

Shrublets with many spreading stems; branches wiry and often scrambling, pubescent to glabrescent with few or no simple hairs (0.3–0.6 mm long) over radial multiangulate stellate hairs (4–7 (-10) subequal branches) of similar size or rarely with a few larger stellate hairs (2,3 branches) below flowers. *Cauline leaves* linear, or if oblong to oblong-elliptic then glabrescent, 3.8–21.4 × 1.1–3.2 mm, with revolute margins appressed against central ridge so that the undersurface of the leaf is rarely visible between them, more or less straight and spreading from the petiole even when old, with antrorse simple hairs if present. *Flowers* stalked, singly, rarely in loose terminal corymbiform polymonads of up to 3. *Flowering*: mainly Aug.–Nov. Fig. 5A–D.

Distribution and ecology

Recorded from various soil types but often associated with surface limestone in South Australia, especially from southern Yorke Peninsula and mainly the south-eastern Eyre Peninsula.

Conservation status. Restricted distribution but locally common and conserved in a few parks.2RCa.

Variation

While the number of stellate hairs on the branches increases acropetally this apparently does not apply to the number of simple hairs of which there are only few below the terminal flowers. Since, however, the hypsophylloids on these terminal branches are caducous especially on dried herbarium sheets, one must be careful not to interpret the long simple hairs of the axillary tufts of these hypsophylloids, which are often numerous and developed in quick succession, as simple hairs on the stems. In this region the longer erect type of stellate hairs as found in the other two subspecies were also occasionally observed. The calyx of plants particularly from the Eyre Peninsula are usually almost glabrous, while they often have coarse simple hairs on the Yorke Peninsula (e.g. *H.R. Toelken 8564*, 5.7 km S turnoff to Corny Point lighthouse). This collection also shows plants with many rigid stems developed under the harsh conditions on sand behind the coastal cliffs; *H.R. Toelken 8565* (type) represents the most commonly found wiry form from inland localities, and *H.R. Toelken 8566* are little-branched scrambling plants growing in the shade of shrubs near to the previous collection.

Notes

The earliest specimens collected of this taxon were placed by Bentham (1863) tentatively in *H. stricta* var. *hirtiflora* and subsequently by Black (1925, 1926, 1952) under *H. sericea* var. *major*: *sine leg.*, near Spencer Gulf (MEL 35801); *Major Warburton*, Streaky Bay (MEL 35803). It is interesting that no species of the *H. sericea* complex has since been recorded from the north-western Eyre Peninsula. It is likely the Warburton specimen was incorrectly labelled and is more likely from near Port Lincoln.

Tepper (1880) identified a specimen of this subspecies as *H. stricta* in his account of the flora of the Ardrossan area and this was probably accepted by Tate (1890). Black (1926, 1952) seems to have included some of his specimens in *H. sericea*, as he quoted Yorke Peninsula in the distribution of that species but not under the varieties. There are, however, indications that he also quoted some specimens under *H. stricta* var. *glabriuscula*. Jessop (1986) placed the material of this species into *H. sericea* var. *major*, and, although this concept is maintained for the complex, the var. *major* was not raised to species level because it is based on an odd form (cf. variation: subsp. *major*).

Flowers of subsp. *platyphylla* are often more or less stalked so that they form a rather loose terminal polymonads. This makes it difficult to distinguish between flowers of the clusters at the end of branches, which are part of the sympodial growth pattern, and others, which arise as subapical axillary short shoots with a terminal flower, as the latter often also develop a little later as the terminal flower. Short shoots can usually be distinguished by their broad hypsophylloids, while additional flowers of the terminal polymonads are usually subtended by "leaves" that approach depauperate cauline leaves. The latter are much narrower and their revolute margins are well developed for most of their length.

Voucher specimens (42 examined)

SOUTH AUSTRALIA: *N.N.Donner 11095*, ca 3 km from gate to Taylors Landing, 4.xi.1985 (AD, CANB, G, K, MO, NSW); *R.D.Hoogland 11841*, ca 1 mile N White Hut along the Corny Point- Marion Bay road, 11.xi.1970 (AD; B, HBG, CANB, K, L, MEL, UC, US, n.v.); *H.R.Toelken 8564*, cliffs above Berry Bay, 5.7 km S ot turnoff to Corny Point, 1.x.1994 (AD, B, BRI, HBG, G, K, MEL, NSW, PERTH, S, US).

b. subsp. **major** (J.M.Black) Toelken, *stat. et comb. nov.*

H. sericea (R.Br. ex DC.)Benth. var. *major* J.M.Black, Trans. Proc. Roy. Soc. South Australia. 36: 21 (1912); Feddes Repert. Sp. Nov. Regni Veg. 14: 352 (1916); Trans. Proc. Roy. Soc. South Australia 49: 274 (1925), partly, excl. Kangaroo Island; Fl. S. Austral. 1 edn, 3: 386 (1926), partly; Fl. S. Austral. 2 edn, 3: 575 (1952), partly; Jessop in Jessop & Toelken, Fl. S. Austral. 1: 358 (1986), partly.

Type: South Australia, near Port Lincoln, *H.H.D.Griffith s.n.*, 15.x.1909 (lecto.: AD ; iso.: K, MEL 35797, NSW 85983).

H. sericea auct. non (R.Br. ex DC.)Benth.: Tate, Handb. Fl. Extratrop. S. Austral. pp. 24, 205 (1890), partly.

Shrubs with few stiffly erect stems; branches rigidly woody, with many simple hairs (0.6–1.8 mm long) over usually erect multiangular stellate hairs of two sizes, the fewer larger stiffly erect ones ((1) 2, 3 often unequal branches) of varying size over smaller erect and/or radial ones (3–5 subequal branches) of similar size. *Cauline leaves* linear to oblong, if oblong-elliptic then straight when old, (4.3-) 7.5–16 (-26.4) × (1.1-) 1.5–3.5 (-4.8) mm, with revolute margins often not appressed to the central vein so that the tomentose undersuface often becomes slightly visible, rarely obviously showing, more or less straight and spreading from the petiole even when old, with antrorse simple hairs over shorter antrorse to radial stellate hairs (1–3(4) subequal branches) acropetally. *Flowers* sessile to slightly stalked, (1-) 3–7 (-15) in terminal corymbiform polymonads. *Flowering*: mainly Aug.–Nov., and often ripe seed is shed concurrently with later flowers. Fig. 5I–P.

Distribution and ecology

On sandy to sandy clay soils and often associated with rocky slopes in woodland; restricted to South Australia where it occurs mainly on the southern but also into central Eyre Peninsula as far north as Mt Olinthus and Middlecamp Hills Conservation Park, and in a few localities in central Yorke Peninsula.

Conservation status: Locally common on mainly the southern Eyre Peninsula but very local further north, and present in several conservation parks.

Variation

The type specimen belongs to a particularly robust form found mainly north-west of Port Lincoln and which was initially distinguished because of its long hairs, leaves with scarcely recurved margins and a central vein often just reaching their apex. Juvenile growths of other plants are, however, often equally vigorous and fall into the range of variation of these plants so that it was found impossible to delimit this form. Even the number of stamens tends to increase in such robust plants.

Although the calyx of most of the species of this complex is more or less accrescent it is particularly noticeable in this subspecies.

Notes

The var. *major* was based on a specimen by H.H.D.Griffith collected near Port Lincoln on 15.x.1909. Only a few days earlier S.A.White collected the same taxon at Warunda on 9.x.1909, but the earliest specimens known of this plant are: *J.St.Browne MEL 35795*, Port Lincoln, 1874; *(Schmid sub J.G.O.Tepper*, Warrow, 1879(AD); *Mrs Richards s.n.*, between Port Lincoln and Streaky Bay, 1883 (AD; MEL 35800). Black (1925, 1926) recorded it also from Kangaroo Island as he was probably referring to a H.H.D.Griffith (x.1908) specimen of *H. villifera*, which was mounted on the same sheet as the lectotype, and in 1952 he erroneously extended the distribution to western Victoria. Jessop (1986) included material of subsp. *platyphylla* from the Eyre and Yorke Peninsulas and rather large flowered specimens, including *H. villifera* from the Southern Lofty region.

Typification

The specimen of the type collection (*H.H.D.Griffith s.n.*, 15.x.1909 from near Pt Lincoln) of ***H. sericea* var. *major*** in AD was selected as the lectotype because it, in contrast to isotypes in other herbaria, is accompanied by notes and a dissection. On the same sheet was also mounted a (not type) specimen of *H. villifera* (*H.H.D.Griffith s.n.*, x.1908), which is not mentioned in the protologue but in all his subsequent publications reference is made to Kangaroo Island; and a later (not type) specimen *H. sericea* (*F.Mueller s.n.*, Austral. Felix, received from the National Herbarium, Victoria in 1944), which is presumably the reason for extending the distribution to western Victoria in Black (1952).

Voucher specimens (84 examined)

SOUTH AUSTRALIA: *B.J.Blaylock 813*, Section 141, Hundred of Curramulka, 7.x.1967 (AAU, AD; B, C, H, K, P, SI, TI, n.v.); *D.E.Symon 6545*, Hincks National Park, "Oak Amphitheatre", 13.x.1968 (AD, CANB, K); *D.J.E.Whibley 7256*, Mt Olinthus, 1.x.1980 (AD, K, NSW, PERTH); *P.G.Wilson 355*, Warrow – Edillilie road, 10.x.1958 (AD; G, IA, K, L, P, n.v.).

c. subsp. **halmaturina** Toelken, *subsp. nov.*

H. sericea (R.Br. ex DC.) Benth. var. *scabrifolia* J.M.Black, Trans. Proc. Roy. Soc. South Australia 49: 278 (1925), partly, as for "Cape Borda, *H.D.D.Griffith s.n.*" and "Rocky River, *J.B.Cleland s.n.*" cf. *H. sericea*: typification.

H. sericea var. *major auct. non* J.M.Black: Jessop in Jessop & Toelken, Fl. S. Austral. 1: 358 (1986), partly.

A subspecie typica pagina infera exposita foliorum plurimorum foliisque veterioribus recurvis; a subsp. *majore* foliis oblong-ellipticis veterioribusque recurvis differt.

Type: South Australia, Kangaroo Island, Rocky River to Cape Borda, ca 1.5 km before turnoff to West Bay, *H.Eichler 15538* (holo.: AD; iso.(n.v.): K, MEL, NSW, NY, PERTH).

Shrubs with few stiffly erect stems; branches rigidly woody, with many simple hairs (0.3–0.8 mm long) over few longer stiffly erect stellate hairs (1–3 often unequal branches) and smaller erect and/or radial ones (3–6 subequal branches) all of similar size. *Cauline leaves* elliptic to elliptic-oblong, (2.2-) 3.6–7.5 (-11.4) × (0.9-) 1.3–2.2 (-2.8) mm, with undersurface showing between the central ridge and revolute margins, more or less recurved along the whole length when old, with spreading simple hairs above. *Flowers* sessile, 1–3(-5), in terminal corymbiform polymonads. *Flowering*: Aug.–Dec. Fig. 5E–H.

Distribution and ecology

Grows on laterite usually under mallee mainly in the western parts of Kangaroo Island (South Australia).

Conservation status. Scattered plants are rarely common but often recorded from Flinders Chase National Park. 2RCa.

Notes

The western population is of remarkably uniform plants with short recurved cauline leaves, the central vein of each constricting more or less abruptly into the apex in this resembling leaves of subsp. *major* or *H. villifera*. The latter two are, however, distinguished by their long marginal simple hairs over stellate ones on the upper leaf surface.

The central vein also does not continue to the apex of cauline leaves of *H. sericea*, which occurs in a few coastal localities on Kangaroo Island, while the somewhat similar subsp. *halmaturina* has been recorded from inland localities. Three specimens from near Muston (*H.M.Cooper AD 96452008, AD 97938048, B.M.Overton 99*) are here included in the broad concept of *H. sericea* although they have a similar rigid habit and rounded to truncate leaves with the central vein without stellate hairs, and are in the case of *B.M.Overton 99* distinctly recurved. However, unlike subsp. *halmaturina*, the central vein of the cauline leaves of these specimens does not visibly join the apical margin. Although these three specimens are different from others recorded from Kangaroo Island, they are easily matched with specimens of *H. sericea* from south-eastern South Australia.

Etymology

The epithet, "*halmaturina*", Greek, "*halma*" "a leap" and "*uora*" "a tail", alludes to kangaroos, and when combined with the Latin geographical ending "*-ina*" it refers to Kangaroo Island, where this subspecies is endemic.

Voucher specimens (26 examined)

SOUTH AUSTRALIA: Kangaroo Island: *E.N.S.Jackson 4445*, Ravine des Casoars, 24.viii.1982 (AD); *G.Jackson 1502*, near Mr Rex Ellis's property, 14.viii.1981 (AD); *E.C.Nelson 17437*, Brakeneck Creek, -.xi.1973 (AD, CANB).

H. praemorsa Toelken, *sp. nov.*

A *H. patenti* 7–9 staminibus, foliis latioribus cum costis centralibus complanatis differt; *H. bracteatae* similis sed absentia bractearum sub florem et tomento glabrescenti differt.

Type: New South Wales, Morton National Park, site 1, *P.M.Jordan s.n.*, 18.ii.1999 (holo.: AD; iso.: K; MEL; MO; NSW).

Shrubs up to 1.3 m tall, more or less branched, villous. *Vestiture* on all parts a mixture of long and short spreading simple hairs, both more or less tubercle-based particularly on leaves and spreading at ca 90° unless restricted and then antrorse. *Leaves* with axillary tuft of hairs scarcely elongating acropetally to 1.5 mm long; petiole 0.2–0.4 (-0.6) mm long; *lamina of cauline leaves* and *hypsophylloids* oblong-elliptic, (5.1-) 6.5–9.5 (-13.2) × (2.4-)

3–4.5 (7.6) mm, obtuse to rounded or slightly emarginate due to recurved apex, usually abruptly constricted into petiole, central vein (0,3–0.4 mm wide in the middle) scarcely raised but visibly continued into the tufted recurved apex, with undersurface visible, villous to sericeous. *Flowers* single, terminal commonly on main branches; *bracts* like cauline leaves. *Calyx* scarcely accrescent, green; *outer calyx lobes* lanceolate to narrowly oblong-lanceolate, pointed to almost acuminate, margins not recurved, 6.5–9.3 × 1.6–2.1 mm, outside villous to appressed-pubescent, inside the upper third rarely with appressed silky hairs; *inner calyx lobes* oblong-elliptic to oblong-lanceolate, acute to pointed, rarely cuspidate, 6.1–7.7 × 2.8–3.3 mm, outside more or less appressed, pubescent to puberulous and glabrous towards the margins, inside glabrous. *Petals* broadly obovate, 5.1–8.8 mm long, slightly emarginate, yellow with reddish main vein. *Stamens* 7–9, side ones often longer; filaments more or less basally connate, anthers narrowly oblong, (2.3-) 2.4–2.6 mm long, dehiscing mainly by terminal pores and later by lateral slits. *Pistils* 2, each ovoid, with 4 ovules, style from outer apex, then spreading laterally of clustered stamens. *Fruit* villous with simple hairs. *Seeds* (slightly immature ones seen) brown, broadly obovoid, laterally compressed, ca 2.2 × 2.4 mm, aril a fleshy ring basally expanding into scarcely lobed sheath surrounding and appressed to base of seed.. *Flowering*: Oct.; Jan., Feb. Fig. 6A–G.

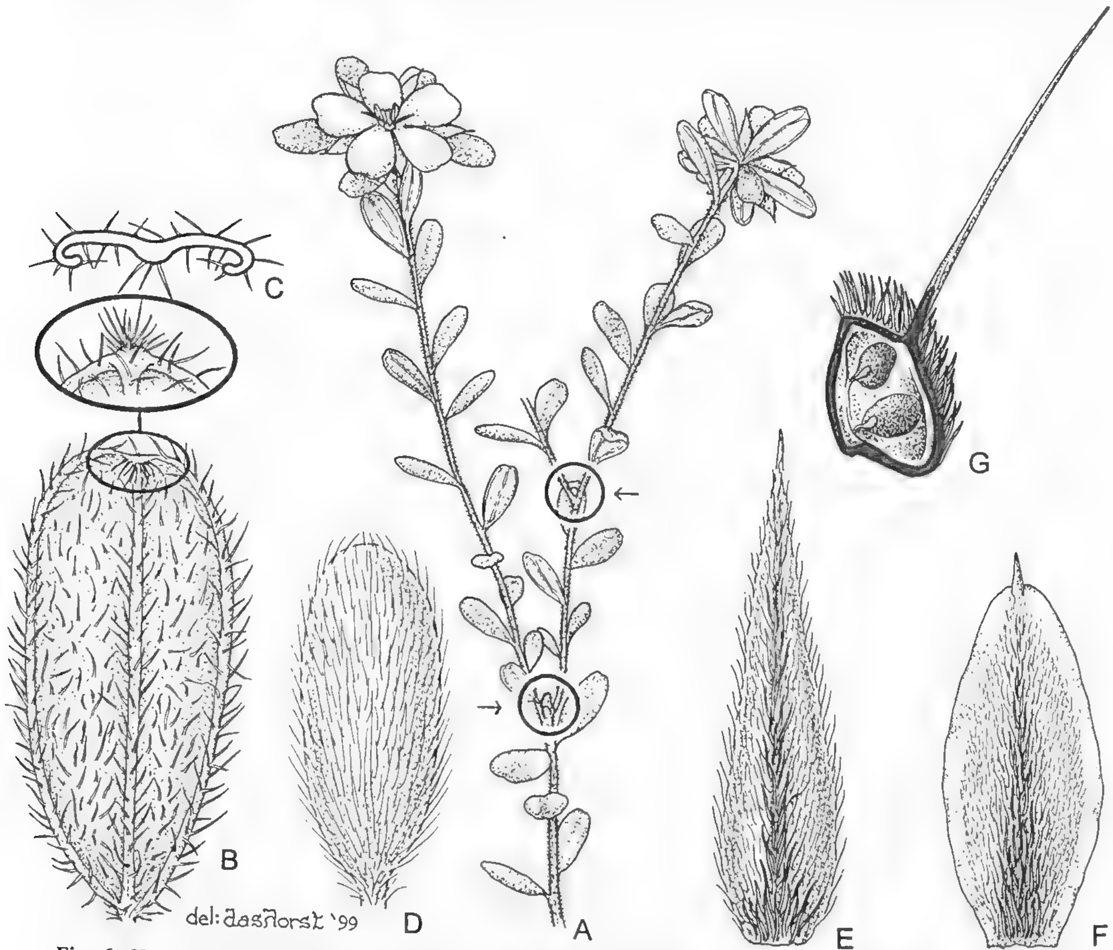


Fig. 6. ***H. praemorsa***. **A**, Flowering branch with scars of two previous flowers; **B**, cauline leaf; **C**, transverse section; **D**, bract; **E**, outer calyx lobe; **F**, inner calyx lobe; **G**, half a pistil with ovary covered with simple hairs. (**A–G**, *P.Jordan s.n.*, AD; **A** ×½; **B**, **C** ×6; **D** ×10; **E**, **F** ×8; **G** ×30).

Distribution and ecology

Grows on steep rocky sandstone slopes with *Eucalyptus sieberi*, *Allocasuarina littoralis*, *Hakea salicifolia*, *Isopogon aridifolius*, *Acacia terminalis* and *Philotheca* (*Eriostemon*) *scabra*; in northern Morton National Park (New South Wales: ST), or associated with *Eucalyptus multicaulis*, *Philotheca*, *Hakea dactyloides* and *Banksia spinulosa* on similar aspects in the southern locality.

Conservation status. Known only from two populations with more than 600 plants in northern Morton National Park and one record but with unknown size of population/s from the northern Budawang Range in the same park. 2RCi.

Diagnostic features

The whole plant and especially the leaves are, as in *H. patens*, covered with long and short simple hairs, which are spreading up to 90°, but in spite of this superficial resemblance, *H. praemorsa* is distinguished by its scarcely broadened and thickened central vein, broader leaves, the usually unequally long stamens, and sideways spreading stigmas. The broad leaves could be confused with those of *H. bracteata* except for its spreading hairs and scarcely developed central vein. In *H. praemorsa* also the leaves below the flowers are not reduced to scale-like 'bracts'. The relatively broad leaves with a narrow central vein and covered with spreading hairs resemble those of *H. hirta,* also from Morton National Park, but the flowers are sessile and the hairs are all simple in *H. praemorsa.*

Variation

Except for variation in size of the various organs the present material shows little variation. The calyx of some of the flowers from the southern population is more distinctly acuminate than of the northern ones.

Notes

The specimen from the southern locality was collected on the 2nd October so that it is flowering like most other species of *Hibbertia* in the area during September and October. According to the collector of the northern specimens the main flowering period of the species there is February, which is unusually late for hibbertias from south-eastern Australia.

Etymology

The abrupt constriction of relatively broad leaves into a rounded, truncate or even slightly emarginate apex often appears "bitten off", Latin, "*praemorsa*" as referred to in the specific epithet.

Specimens examined

NEW SOUTH WALES: *P.Gilmour 5272*, northern Budawang Range, 2.x.1985 (CANB); *P.M.Jordan s.n.*, S Bundanoon, i.1997 (AD).

H. puberula Toelken, *sp. nov.*

H. sericea auctt. non (R.Br. ex DC.)Benth.: A.A.Hamilton, Proc. Linn. Soc. New South Wales 34: 118 (1909); N.C.W.Beadle et al., Vasc. Pl. Sydney 1 edn: 196 (1963), partly; G.J.Harden & J.Everett in G.J.Harden, Fl. N.S.W. 1: 302(1990), partly; Carolin et al., Vasc. Pl. Sydney 4 edn: 274 (1993), partly.

A *H. sericea* costa centrali foliorum extensa ad apicem et pagina infera invisibili, nonnunquam pilis stellatis, absentia hypsophylliodum; a *H. simulanti* et *H. patenti* ovariis puberulis vel glabrescentibus, habitu decumbenti differt.

Type: New South Wales, Yowie Bay, *A.A. Hamilton s.n.*, 14.xi.1908 (holo.: NSW 101955, sheet two; iso.: NSW 101955, sheet one; CANB, n.v.).

Shrublets with few spreading but ultimately wiry branches up to 30 cm long, sparsely branched, pubescent, often glabrescent. *Vestiture* on all parts varying but becoming denser acropetally, consisting of longer over shorter simple hairs and both types usually with pronounced basal tubercles; *on branches* and *leaves above and below* fine spreading hairs rarely exceeding 0.7 mm; *on outer calyx lobes* outside with coarse longer hairs (up to 1.3 mm) antrorsely curved and/or some hooked (but sometimes reclining) over smaller hooked reclining (rarely inclining) ones, inside with fine straight longer and shorter simple hairs over much of the surface; *on inner calyx lobes* longer coarse simple hairs usually restricted to along the central vein while short hooked hairs also laterally spreading often almost to the margins. *Leaves* with axillary tuft of hairs elongating acropetally to 0.8 mm long, often slightly continued on both sides of decurrent base of petiole; petiole 0.2–0.5 mm long; *lamina* oblong-lanceolate to almost linear, (1.2-) 3.2–5.5 (-7.9) × (0.6-) 0.8–1.4 (-1.8) mm, acute, sometimes becoming obtuse, abruptly constricted into petiole, with broad central vein (0.4–0.6 mm wide in the middle) continued into apex but recessed from revolute margins, above and below minutely scabrous to glabrescent, with undersurface not visible. *Flowers* single or rarely in a cluster consisting of up to 3 on short shoots subtending the terminal flower, terminal mainly on main branches but also on short shoots; *bracts* elliptic to elliptic-lanceolate, (2.9-) 3.2–3.5 (-4.0) × 0.6–0.72 mm, leaf-like but often slightly flattened and central vein often indistinct, minutely scabrous to glabrescent. *Calyx* more or less accrescent; *outer calyx lobes* ovate. more or less beaked with recurved margins towards the apex, (5.8-) 6.8–8.5 (-10.2) × (1.7-) 2.5–3.8 (-4.2) mm, longer than inner ones, outside hispid, one- to two-thirds covered on inside, pubescent to silky; *inner calyx lobes* oblong-elliptic to oblong-ovate, (4.9-) 5.8–6.6 (-7.4) × (1.8-) 2.1–2.6 (-3.2) mm, hispid with spreading bristles mainly along the central ridge and becoming abruptly shorter to the sides, which are largely glabrous. *Petals* obovate, 6.0–8.3 mm long, broadly bilobed but usually with cuneate base. *Stamens* (9) 10–14, subequal; filaments ca one-third connate; anthers oblong, 1.3–2 mm long, dehiscing by terminal pore and lateral slits. *Pistils* 2, almost spherical, with (4-) 6 ovules, style with base recurved along the apex of the ovary, then arched around cluster of anthers, pale. *Fruit* puberulous with simple hairs. *Seed* brown, obovoid, 1.8 × 1.3–1.4 mm, aril a fleshy ring scarcely expanding into surrounding sheath, on lateral base. *Flowering*: Oct., Nov. Fig. 7A–G.

Distribution and ecology

Recorded from sandy soil often associated with sandstone mainly from coastal areas in New South Wales (CC).

Conservation status. Poorly known, but probably endangerwed due toi urban spread as the most recent collections of the species were made 45 years ago. 2K.

Diagnostic feature

H. puberula closely resembles species of the *H. sericea* complex in that it sometimes produces similar sympodial clusters of terminal flowers, the outer calyx lobes often have the upper margins recurved (cf. *H. crinita*), and the long hairs of the axillary tufts more or less continue along the base of the petiole. However, it is easily distinguished from other species by the combination of its linear-lanceolate leaves with a central vein raised up to the leaf apex, only simple hairs, absence of a tuft of hairs between the stamens and the petals, a puberulous ovary, and obloid seeds.

This species has often been combined with *H. simulans* (see below), but is distinguished by its puberulous ovary and its decumbent habit with wiry branches.

Variation

The sympodial clusters of terminal flowers is not a common phenomenon in the species and was best observed on one sheet (NSW 101955) of two by *A.A. Hamilton s.n.*, xi.1908.

Etymology

The epithet "*puberula*", Latin, "minutely pubescent" refers to the few short soft simple hairs on the leaves and more importantly on the ovary, being a characteristic feature of this species.

Specimens examined

NEW SOUTH WALES: *W.F.Blakely & D.W.C.Shiress NSW 101951*, Canoe Ground, Hawkesbury River, 14.x.1927 (CANB, NSW); *E.F.Constable NSW 101959*, Blaxland, 28.x.1949 (NSW, CANB); *A.A.Hamilton NSW 101955*, Yowie Bay, 14.xi.1908 (CANB, NSW); *J.M.Lindale NSW 101952*, Frenchs Forest, -ix.1946 (CANB, NSW); *K.Mair NSW 101954*, South Coogee, 27.xi.1954 (NSW).

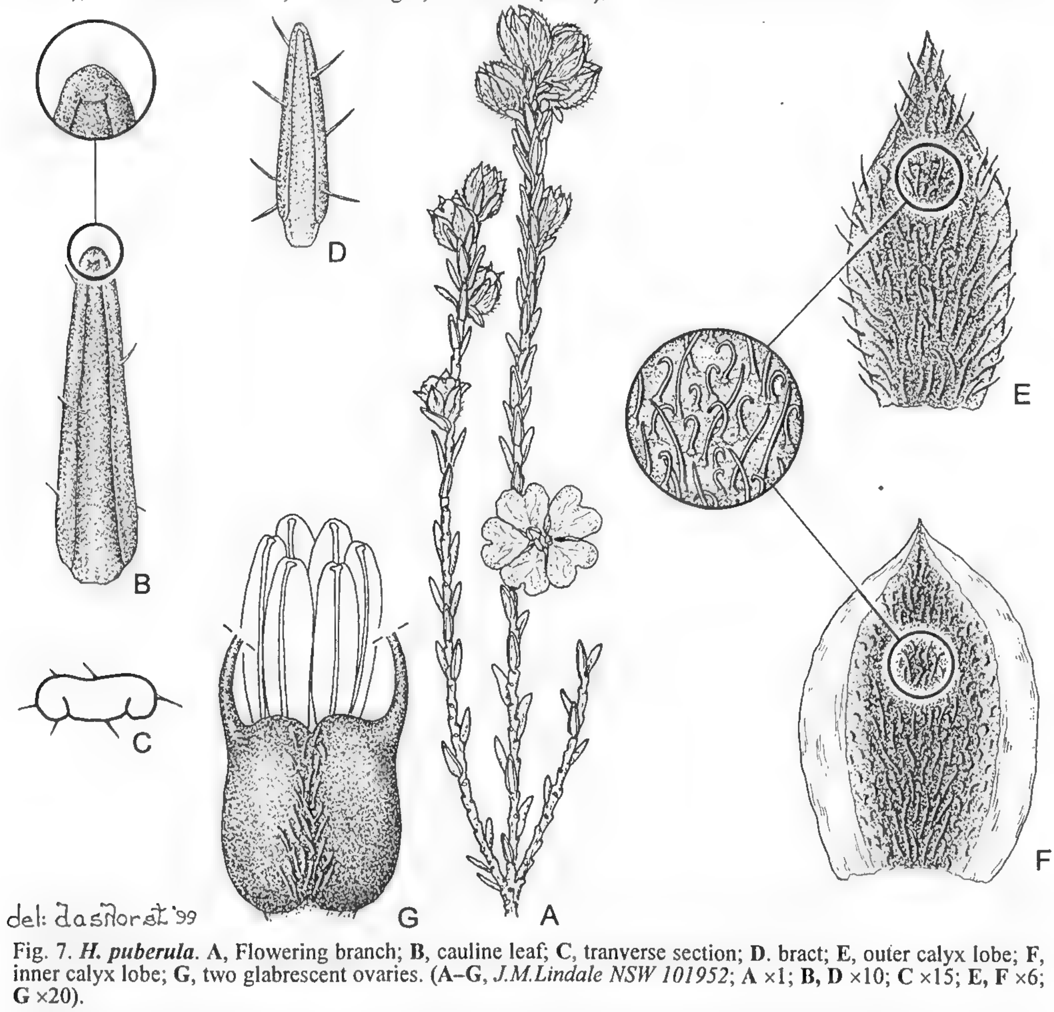


Fig. 7. ***H. puberula***. **A**, Flowering branch; **B**, cauline leaf; **C**, tranverse section; **D**. bract; **E**, outer calyx lobe; **F**, inner calyx lobe; **G**, two glabrescent ovaries. (**A–G**, *J.M.Lindale NSW 101952*; **A** ×1; **B, D** ×10; **C** ×15; **E, F** ×6; **G** ×20).

H. sericea (R.Br. ex DC.)Benth., Fl. Austral. 1: 26 (1863), partly; Spicer, Handb. Pl. Tasm. 100 (1878); C.Moore, Cens. Pl. N.S.W. 1(1884), partly; Tate, Handb. Fl. Extratrop. S. Austr. 14, 205 (1890), partly; Gilg, Pflanzenfam. 3, 6: 120, fig. 61F, G[very poor] (1893),

partly; Ewart, Fl. Vict. 769 (1930), partly; Gilg & Werderm. Pflanzenfam. 2 edn, 21: 30 (1925), partly; J.M.Black, Trans. Proc. Roy. Soc. South Australia 49: 274 (1925), partly; Fl. S. Austral. 1 edn, 3: 386 (1926), partly; Fl. S. Austral. 2 edn, 3: 575 (1952), partly; W.M.Curtis, Fl. Tasm. 20 (1956), partly; H.Eichler, Suppl. Fl. S. Austral. 226 (1965); partly; J.Galbraith, Wildfl. Vict. 3 edn, 93, fig.98 (1967), partly; Willis, Handb. Pl. Vict. 2: 390 (1973), partly; Jessop in Jessop & Toelken, Fl. S. Austral. 1: 357 (1986), partly; Toelken in Walsh & Entwisle, Fl. Vict. 3 : 310 (1996).

Type: Victoria, near Port Phillip, *R.Brown s.n.* (lecto. – selected here: G-DC; iso.: BM, n. v.; MEL 35698 ; syn.: *J.B.LT.Leschenault s.n.*, P, n.v.).

Pleurandra sericea R.Br. ex DC., Regn. Veg. Syst. Nat. 1: 416 (1817); Deless., Ic. Sel. Pl. 1: 21, t. 79 [poor] (1821); Steud., Nomencl. Bot. Pl. Phan. 1 edn, 633 (1821); 2 edn, 2: 355 (1841); Hook.f., Fl. Tasm. 1: 16 (1855), partly, excl. *P. cinerea*; Hannaford, Jottings in Austral. 36 (1856); F.Muell., Ann. Rep. Govt Bot. Dir. Bot. Gard., 24 (1858).

P. densiflora Hook., J. Bot. (Hook.) 1: 245 (1835); Hook.f., J. Bot. (Hook.) 2: 401 (1840); Walp., Rep. Bot. Syst. 1: 64 (1842).

Type: Tasmania, *R.W.Lawrence 227* (K, n.v.)

H. densiflora (Hook.)F.Muell., Pl. Indig. Col. Vict. 1: 15 (1862), *nom. illeg.*; Fragm. 7: 125 (1871), partly; Fragm. 11: 92 (1880), partly; Syst. Census 1 (1882), partly; Sec. Syst. Census 1(1889), partly; Tate, Trans. Proc. Roy. Soc. South Australia 3: 50 (1880); C.Moore & Betche, Handb. Fl. N.S.W. 10 (1893); Rodway, Fl. Tasm. 4 (1903), partly; Maiden & Betche, Census N.S.W. Pl. 139 (1916).

H. sericea (R.Br. ex DC.)Benth. var. *sericea*. Benth., Fl. Austral. 1: 26 (1863), partly; J.M.Black, Trans. Proc. Roy. Soc. South Australia 49: 274 (1925), partly; Fl. S. Austral. 1 edn, 3: 386 (1926), partly; Fl. S. Austral. 2 edn, 3: 575 (1952), partly; Willis, Handb. Pl. Vict. 2: 390 (1973), partly; Jessop in Jessop & Toelken, Fl. S. Austral. 1: 357 (1986), partly; Toelken in Walsh & Entwisle, Fl. Vict. 3 : 311 (1996).

H. sericea (R.Br. ex DC.)Benth. var. *densiflora* (Hook.)Benth., Fl. Austral. 1: 26 (1863).

Type: as for *P. densiflora*.

H. sericea (R.Br. ex DC.)Benth. var. *scabrifolia* J.M.Black, Trans. Proc. Roy. Soc. South Australia 49: 274 (1925); Fl. S. Austral. 1 edn, 3: 386 (1926); Fl. S. Austral. 2 edn, 3: 575 (1952); Willis, Handb. Pl. Vict. 2: 390 (1973); Toelken in Walsh & Entwisle, Fl. Vict. 1: 357 (1996).

Type: South Australia, Keith, *J.M.Black s.n. & ADB*, 22.xi.1917 (lecto – selected here: AD; syntypes: Mt McTyre (AD); without locality or date, *J.M.Black s.n.* (AD); Tintinara, *J.M.Black s.n.*(AD); East Wellington, *J.M.Black s.n.* (AD); Cape Borda, *H.H.D.Griffith s.n.* (AD – excl.); Keith, *J.M.Black s.n. & ADB*, 23.xi.1917 (AD); S. Lameroo, *J.M.Black s.n.*, 15.x.1918 (AD); Cape Bonney, *J.B.Cleland s.n.*, xii.1922 (AD); Rocky River, *J.B.Cleland s.n.*, 18.x.1924 (AD – excl.); Streaky Bay, *Major Warburton s.n.* (MEL 35803 – excl.) see typification).

Shrubs 0.3–1.2 m tall, with few erect to spreading branches, becoming moderately to densely branched, villous to pubescent. *Vestiture* on all parts consisting of simple hairs (0.1–1.8 mm long) over stellate hairs (rarely locally absent), both more or less tubercle-based and becoming denser acropetally; *on branches* with more or less scattered simple hairs often wearing off on lower branches but below flowers often of similar length to those of the tufts in the axils of leaves, which thus appear to overflow to both sides and along the decurrent leaf bases, over multiangulate radial stellate hairs usually of different sizes (2–5 often unequal branches) increasing in number and size acropetally (3–8 (-10) usually subequal branches); *on leaves above* with few to many usually antrorse simple hairs, often of different size, becoming longer and spreading towards the margins, sometimes wearing off, over few (rarely none), but increasing below flowers, antrorse to rarely only radial multiangulate stellate hairs (2–5 usually subequal branches); *on leaves below* with more or less scattered antrorse simple hairs along the margins and central vein over radial multiangulate stellate hairs (5–8 usually subequal branches) or only densely matted ones (7–12 subequal branches) on the undersurface, if visible; *on hypsophylloids* above with usually many antrorsely inflexed to appressed simple hairs over usually antrorse (rarely radial) multiangulate stellate hairs, below with few to rarely many antrorsely curved simple hairs over mainly dense, often antrorse, multiangulate stellate hairs; *outer calyx lobes* with

few to many antrorsely inclined or curved, often coarse, simple hairs over radial (rarely antrorse) multiangulate stellate hairs (3–7 usually subequal branches) to radial or rarely pulvinate ones (many subequal branches) towards the sides; on *inner calyx lobes* with few or no antrorse simple hairs along the central vein over short radial to pulvinate multiangulate stellate hairs (many subequal branches), and often with simple- to stellate-ciliate margins. *Leaves* with axillary tuft of hairs elongating acropetally up to 1.2 mm long, often continued along both sides of decurrent base of petiole; *lamina of cauline leaves* linear-oblanceolate to linear-lanceolate, rarely linear-elliptic, 2.6–17.8 × 1.8–5.6 mm, gradually or scarcely tapering into petiole, obtuse often becoming acute, rarely acute, with central vein visible for two-thirds to seven-eighths of their length and often broader and usually shallower than the revolute margins (0.2–0.4 (-0.6) mm wide at the middle), above pilose or pubescent to glabrescent, below tomentose with undersurface usually visible and then leaves discolourous; *lamina of hypsophylloids* linear-elliptic to ovate, (1.8-) 3.5–10 (-12.4) × 0.8–3(-5.6) mm, scarcely tapering into petiole, bluntly acute to obtuse, like cauline leaves, velutinous to tomentose on both surfaces. *Flowers* sessile, (1-) 3–9 (-15) in broad rarely oblong corymbiform polymonads, subtended by few to many hypsophylloids, terminal on main or lateral branches and often on short shoots; *bracts* lanceolate to ovate, 1.6–11.8 × 0.7–4.4 mm, similar to hysophylloids, flat with margins recurved mainly towards the apex, central vein broader and shallower, tomentose to velutinous above and below. *Calyx* often turning reddish-brown, scarcely accrescent; *outer calyx lobes* lanceolate, 3.9–8.1 × 1.9–3.4 mm, acute, with scarcely recurved margins towards the apex, scabrous, inside on upper half appressed-villose; *inner calyx lobes* oblong-ovate, 3.8–7.3 × 3.7–5.9 mm, obtuse, stellate-tomentose with some scabrous hairs along the ridges. *Petals* obovate, rarely with cuneate base, (6.7-) 8.5–14 (-16.3) mm long, distinctly bilobed. *Stamens* (6-) 8–10 (-15), subequal; filaments basally connate, *anthers* obloid, (1.6-) 1.8–2.2 (-2.6) mm long, dehiscing by terminal pore and lateral slits. *Pistils* 2, scarcely laterally compressed, with 4–8 ovules, style base recurved along the upper third of ovary, then arched around the cluster of stamens, yellow, sometimes turning red. *Fruit* stellate-tomentose. *Seed* brown to shiny black, obovoid to almost spherical, 1.8–2.2 × (1.6-) 1.8–2.2 mm, aril with fleshy base and scarcely lobed sheath surrounding and appressed to base of seed. *Flowering*: Aug.–Nov. *Common name*: Silky Guinea-flower (Willis 1973, Jessop 1986). Fig. 8A–O.

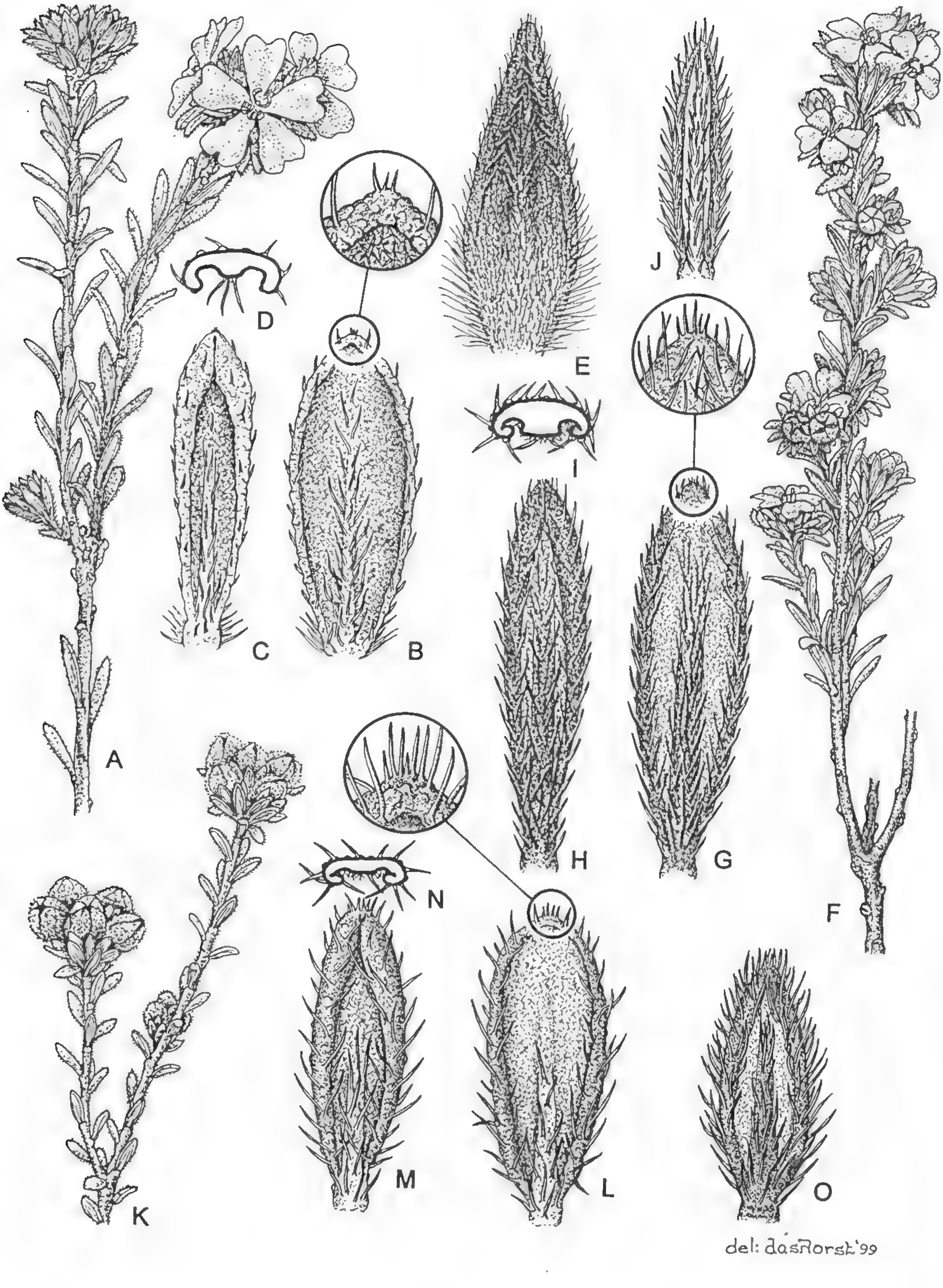
Distribution and ecology

Usually grows in sandy soils often associated with woodland or mallee but most commonly found in coastal heath or low woodland, which is often associated with wetter and swampy conditions in south-eastern to western Victoria (LMAL, WIM, WAN, GR, OTPL, OTRA, GPL, PROM, EG), mainly northern Tasmania and south-eastern South Australia (MU, SL, KI (2 specimens), SE).

Conservation status. All forms of the species occur widespread and are often locally common.

Diagnostic features (see also under variants below)

H. sericea is distinguished from other taxa in this complex by the central vein being visible to two-thirds to seven-eighths of the length of cauline leaves, the presence of predominantly simple hairs on the upper leaf surface (as opposed to mainly stellate hairs in *H. crinita*, as discussed there), and stellate hairs usually covering more than one-third of the inner surface of the outermost calyx lobe. The central vein only being visible for part of the length of the leaves may not be clearly visible in depauperate plants or specimens from drier areas because of the strongly revolute margins of the leaves.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H. villifera is very similar to *H. sericea*, particularly to the form "Densiflora", which shares more or less oblong leaves, a pronounced central vein almost to the apex, and styles often becoming red during flowering. But the former is distinguished by its mainly terminal polymonads, the long silky simple hairs (1.8–2.4 mm long), the larger over smaller stellate hairs on the undersurface of particularly the acropetal parts of cauline leaves and especially leaves below the flower clusters, and plants usually grow on dry sandy or lateritic soils.

Variation

The number of stamens and ovules per carpel vary from one population to another but could not be linked to other characters. In *H. sericea* the stamens are generally densely clustered with the inner ones more or less leaning over the ovaries between the two styles. In "Scabrifolia" the usually distinctly longer central inner stamen, which, as in *H. stricta* var. *glabriuscula,* is situated behind the gap between the two ovaries, is thought to be part of a specific pollination syndrome. The phenomenon is less distinct in "Densiflora" because there are often two or three longer stamens, which, in contrast to "Scabrifolia", have no raised connective or short appendage.

In a variable species like this the choice of material to be examined for identification can be critical as in some forms (e.g. *M.C.R.Sharrad 158*, Cooke Plains; AD) the leaves develop early the dense indumentum typical of leaves below the flowers, and these may resemble the cauline leaves of *H. crinita*. While cauline leaves of *H. sericea* can normally be identified by their central vein not reaching the apex, it may be visible to the apex on leaves below the flowers. Plants which must be identified as *H. sericea* because of the dissimilar denseness of the indumentum on both surfaces of the leaves, rarely have the central vein continued to the apex (*R.J.Bates 11690*). Identifications need to be done using lower cauline leaves and the combination of the length of the central vein as well as the indumentum of the upper and lower surface should be used as the hairs may wear off on older leaves of *H. crinita* (e.g. *R.D.Hoogland 11872*). Senescent plants may sometimes have to be assessed because the remaining leaves on the specimen are mainly those from below successive annual flowers interspersed with little real vegetative growth.

In analysing previously recognised local forms it was found that specimens of *H. sericea* fall into two groups. Those with a long and broad central vein visible to just below the apex (ca seven-eighths of the length) of their linear to linear-lanceolate cauline leaves, which are normally acute, and their margins are more or less equally broad all round irrespective of the degree of recurving. In others a narrower central vein is visible for two-thirds of their oblong-oblanceolate (rarely linear) cauline leaves. The former leaves are usually acute, whereas the latter are obtuse unless their margins are strongly recurved due to extreme environmental conditions or preparation of herbarium specimens in which case the apex of the margin is obscured, when the margins are usually obviously broader below the apex of the cauline leaves (cf. fig. 8C, M) of the latter.

Three informal groups, which were at one or other stage recognised at varietal level, are based on these two types of cauline leaves and are here used to describe the variation within the species. "Densiflora" has a broad central vein with up to ten simple hairs abreast at the middle and the vein almost reaches to the apex (to about seven-eighths of the leaf length).

Fig. 8. ***H. sericea***. **A**, Flowering branch of "Sericea" with flower clusters mainly terminal on long branches; **B**, flat cauline leaf; **C**, cauline leaf with rolled margins broader towards the apex; **D**, transverse section; **E**, hypsophylloid/ bract; **F**, flowering branch of "Densiflora" with flower clusters terminal on long and short branches; **G**, flat cauline leaf; **H**, cauline leaf with rolled margins scarcely broader towards the apex; **J**, hypsophylloid/ bract; **K**, branch of "Scabrifolia" in fruit with clusters subtended by short hypsophylloids; **L**, flat cauline leaf; **M**, cauline leaf with rolled margins broader towards the apex; **N**, transverse section; **O**, hypsophylloid/ bract. (**A–E**, *R.D.Hoogland 12422*, NSW; **F–J**, *M.E.Phillips 309*, CANB; **K–O**, *A.C.Beauglehole 84461*, MEL; **A, F, K** ×½; **B, C** ×3; **D, E, G–J** ×5; **L–N** ×8; **O** ×12).

The central vein in "Sericea" and "Scabrifolia" is much narrower, with up to five simple hairs abreast and reaches only two-thirds of the leaf length. They are then further distinguished by the size of the leaf and hypsophylloids, which in the former envelopes the terminal flowers, while they cover only the base of the apparently separate flowers in the latter. Other characteristics are also provided in the description below, but none of them are consistent. Although these groups are locally distinct, no formal taxonomic rank is assigned because many intermediates were observed. Several such intermediate populations were investigated, and, although no definite indications of hybridity, such as abnormal pollen, could be found, the range of variation recorded within restricted areas, especially on Wilsons Promontory and in several localities in south-eastern South Australia indicate some such phenomenon. Other populations have variation patterns which are more complex particularly in south-eastern South Australia. Plants with a pronounced central vein which resemble "Densiflora" have been mainly recorded from coastal areas, often near wetlands, in Tasmania, but similarly also on the mainland from eastern and southern Victoria, where they merge into "Sericea" plants, to western Victoria and south-eastern South Australia to near Victor Harbour, where their range of variation overlaps at various points with that of "Scabrifolia" plants.

This leads me to conclude that the three groups had at one stage been geographically and/or ecologically (but not biologically) isolated and might have developed local forms before they came again into contact. In contrast to these variation patterns "Sericea and "Scabrifolia" apparently do not show any overlap in distributions, and intermediates can usually be identified by the use of secondary characters (cf. "Sericea", variations). The following descriptions are intended to provide a better understanding of the species but more discerning collections representing a more complete range of material found in populations over the whole range of the species are required.

a. **"Sericea"**

Shrubs to 1.2 m tall, with few erect, stiffly woody branches, usually sparsely branched. *Cauline leaves* linear-oblanceolate, rarely linear, (6.3-) 8.5–10.5 (17.8) × (2.1-) 3–4.5 (-5.6) mm, obtuse or rounded and usually exposing much of the undersurface unless becoming rolled and then acute and with broader margins below the apex, above mainly with short simple hairs 0.2–0.5 (-0.8) mm long; central vein (and revolute margins) scarcely broadened (at lower third 1–2 times broader than revolute margins, (3) 4–6 simple hairs abreast) and visible for two-thirds of the length of leaves. *Flowers* (1-) 4–15, in usually rounded terminal polymonads; hypsophylloids lanceolate to ovate, as long as or just longer than calyx, with distinct revolute margins and central vein often almost to the apex. *Outer calyx lobes* linear-lanceolate to lanceolate, longer than inner lobes, usually with distinct central vein and recurved upper margins; *inner lobes* obtuse to rounded, rarely cuspidate. *Stamens* (10-) 12–15. *Diagnostic features*: Both the "Sericea" and "Scabrifolia" types have a short central vein but the former is distinguished from the other two by its larger linear-oblanceolate leaves with the undersurface usually visible.

Variation: Although "Sericea" is usually distinguished from "Scabrifolia" by its larger leaves and hypsophylloids, specimens from the coast between Geelong and Lorne approach an intermediate size. Many of their leaves are 3–5 times longer than broad, a previously held characteristic of "Scabrifolia" (Toelken 1996). These plants seem to represent a local form of "Sericea", as they often have the longer hypsophylloids, never have their leaves so tightly rolled that the undersurface is not visible as well as their more rigid-erect habit.

In the Grampians plants usually grow associated with woodlands on the lower slopes and have usually much broader hypsophylloids except for one record from Mt Abrupt in the south. These southern specimens also have oblanceolate leaves with usually a short central vein at least on lower cauline leaves, but they are commonly broader and with more simple hairs than those of the northern counterparts. Since their hypsophylloids are linear-

lanceolate and frequently longer than the flowers they subtend, it is often not easy to distinguish specimens of this form from those of "Densiflora".

Some collections (e.g. *R.D.Hoogland 11888, 12423, T. & J.Whaite 1484*) from the Grampians have leaves less than 1 cm long, but they were included in "Sericea", because their hypsophylloids are usually longer than the calyx, and they have more than four flowers in their terminal polymonads. The undersurface of the leaves is at least partially visible. But other specimens (e.g. *T.S.Henshall NSW 106155*, from Mt Arapiles) have all the characteristics of "Scabrifolia". Although the two groups have not been recorded from the same area there is a specimen from the Little Desert (*T.S.Henshall MEL 1517518*, 14 mls S Nhill), which does not agree with any other specimen from that area and is identified as "Sericea". There are some intermediate specimens which are at present not fully understood.

Voucher specimens

VICTORIA: *J.Burne NSW 85968*, Lorne, vi.1940 (NSW); *K.Cowle MEL 580024*, Sandringham, - (MEL); *R.D.Hoogland 11888*, ca 1 mile S Cave of Fishes, 20.xi.1970 (MEL); *12423*, near Golton Gorge, 15.ix.1973 (MEL); *A.Morrison BRI 352889*, Brighton, - (BRI); *S.T.W.Parfett 125*, 4 km N Zumsteins, 22.viii.1987 (MEL); *M.E.Phillips 405*, near Anglesea, 18.ix.1961 (CANB); *J.H.Ross 2536*, Rosebud, Mornington Peninsula, 16.viii.1981 (MEL); *H.B.Williamson MEL 85963*, Mt Abrupt, x.1901(MEL).

TASMANIA: *L.G.Adams & C.J Adams 3414*, ca 3 km ESE Port Latta, 9.xii.1977 (CANB).

b. "Densiflora"

Shrubs 0.3–0.6 (-1) m tall, with many spreading, usually stiffly woody branches, much branched. *Cauline leaves* linear to linear-lanceolate, (3.2-) 4.5–10.5 (-15.7) × (0.8-) 1.2–2.5 (-3.1) mm, acute and scarcely exposing the undersurface, revolute margins of similar width all around; above mainly with long simple hairs 0.6–0.9 (-1.2) mm long; central vein (but not revolute margins) considerably broadened (at lower third 2–3.5(-4) times broader than revolute margins, (4) 5–7 simple hairs abreast) and visible to just below the apex. *Flowers* 1–8 (-12) in often oblong, loose terminal polymonads commonly and on short shoots or many lateral branches; *hypsophylloids* linear-lanceolate, usually distinctly longer to as long as calyx, with well-defined central vein and revolute margins. *Outer calyx lobes* linear-lanceolate, usually longer than inner lobes, with more or less distinct central vein and recurved upper margins; *inner lobes* acute to obtuse or rounded. *Stamens* 8–10 (-14), subequal. *Diagnostic features*: Cauline leaves of "*Densiflora*" are distinguished from those of the other two groups by its central vein reaching almost to the apex and being so broad at the middle that it has up to seven simple hairs abreast and is usually broader than the revolute margins.

Variation: "Densiflora", which occurs mainly in coastal Tasmania, is as Gunn stated (*Gunn 636/1837* in K) very variable: "...when exposed to violent winds and spray off the sea, it becomes a very dwarfed plant rarely exceeding 4-6 in. high, and growing in dense tufts. In sheltered spots it attains 12- 18 in." An extremely depauperate specimen from Flinders Island (*J.S.Whinray 1410*) with leaves 2.6-4 mm long, is, however, distinguished from "Scabrifolia" by its almost appressed simple hairs, the pronounced central vein though very short, and hypsophylloids vary from half to as long as the calyx. In South Australia this form in particular is usually associated with temporary wet or swampy conditions.

Only a few seeds were seen of this form and they were slightly narrower than those of the mainland forms so that they were often distinctly longer than broad. But a specimen from near Georgetown (MEL 35717) shows a wide range covering the extremes.

Although the broad central vein of cauline leaves is usually well developed in plants from Tasmania, the occasional one is less well developed (*P.Collier 629, W.M.Curtis HO 29767*). Their hypsophylloids are, however, typical of "Densiflora". But *L.G.Adams &*

C.J.Adams 3414 is indistinguishable from the small form of "Sericea" from between Geelong and Lorne. The many simple hairs commonly found on the broad central vein are very sparse in some local forms.

An unusually hairy form (*P.Collier 4162*, Mines Creek, E Mt Tanner, Flinders Island), which resembles *H. crinita* was retained in *H. sericea*, because of an incomplete central vein on the cauline leaves like plants in "Densiflora", usually producing predominantly simple hairs and few stellate hairs, and the outer calyx lobes scarcely or not at all recurved at the apex and not covered with simple hairs up to half their length on the inside. In addition, the specimen (*W.M.Curtis HO 3248*, near Lady Barron) shows a range of intermediates.

The South Australian plants with a long pronounced central vein and generally resembling "Densiflora" tend to have shorter hypsophylloids, but in contrast to plants of typical "Scabrifolia" they are linear and acute to pointed. Very few records of such plants are available. Plants with a pronounced central vein commonly have oblanceolate leaves with obtuse apex, or becoming acute because particularly in the upper regions the margins are strongly revolute. They are intermediate and mainly restricted to coastal areas.

Voucher Specimens

"Densiflora"

TASMANIA: *F.E.Burbury HO 97765*, Georges Bay, - (HO); *P.Collier 629*, N Bryans Beach, 6.vii.1985 (HO); *W.M.Curtis HO 29767*, near Rocky Cape, ii.1948 (HO); *R.C.Gunn 636*, George Town, 23.x.1844 (NSW); *W.D.Jackson 238*, near Interview River, 15.i.1954 (HO); *J. Milligan 1078*, Oyster Cove, - (HO).

VICTORIA: *P.G.Abell 306 & C.Herscovitch*, 8.6 km from car park along maintenance road to lighthouse, South East Pt, Wilsons Promontory, 5.xii.1986 (NSW); *A.C.Beauglehole 68085*, Bemm River education area, 3.ii.1980 (MEL); *J.Bowen NSW 85967*, Mornington, ix.1940 (NSW); *P.C.Heyligers 80017*, 5 Km SW Hordern Vale, 28.vii.1980 (CANB); *R.D.Hoogland 11910*, road onto Wilsons Promontory, 25.xi.1970 (MEL!; CANB, K, L, HBG, US, n.v.); *M.E.Phillips CBG 12246*, near old aerodrome at north end, Wilsons Promontory, 23.xi.1961 (CANB); *CBG 44913*, Portland, along track towards Pt Danger, 28.x.1971 (CANB); *P.S.Short et al. 3277*, Moleside camping ground, ca 8 km S Drik Drik, 28.ix.1988 (MEL).

SOUTH AUSTRALIA: *J.R.Dodson 148*, Lake Robe, 3.iii. 1972 (AD); *D.Miller 17*, near Parawa, x.1967 (AD); *K.Stove 914*, Tilley Swamp, 23.vii.1980 (AD); *L.D.Williams 12418*, Canunda National Park, 16 km from Millicent, 9.vii.1982 (AD).

"Densiflora"→"Scabrifolia"

VICTORIA: *Eckert 27*, Lower Glenelg River, 1891 (MEL 35684); *P.C.Heyligers 80050*, near Cape Nelson lighthouse, 31.vii.1980 (CANB).

SOUTH AUSTRALIA: *N.N.Donner 9013*, ca 3km SE Salt Creek, 1.x.1982 (AD, NSW); *W.E.Poole s.n.*, near Lake Hawdon, xi.1972 (CANB); *P.Wilson 1194*, Lake Bonney, 13.xi.1959 (AD)

"Densiflora" → "Sericea"

VICTORIA: *A.C.Beauglehole 78863 & J.R.Turner*, Gippsland Lakes Reserve, 27.x.1984 (MEL); M.G.Corrick 3346, Bellarine Peninsula, 29.vii.1973 MEL);*T.B.Muir 6197*, 8 km SE Lang Lang, 19.x.1978 (CANB, MEL); *Musgrari MEL 35685*, Wilsons Promontory, - (MEL); *M.E.Phillips CBG 43028*, between Cape Schank & Rosebud, Mornington Peninsula, 23.x.1971 (CANB); *F.M.Reader MEL 35696*, near Melbourne, 1884 (MEL); *O.Thompson 123*, Seaspray-Giffard Road, 19.ix.1982 (CANB – showing a full range, MEL);

TASMANIA: *A.M.Buchanan 11195*, Prime Seal Island, southern Peacock Bay, 13.xii.1988 (HO).

c. "Scabrifolia"

Shrublets to 0.35m tall, with few to many spreading to decumbent, often wiry-woody branches, usually much branched. *Cauline leaves* oblanceolate to linear-elliptic, rarely ovate, (2.6-) 3–5 (-11.3) × (1.8-) 2–2.5 (-3.5) mm, obtuse and undersurface more or less exposed or acute and undersurface usually not or scarcely visible and revolute margins

broader below the apex, above mainly with short simple hairs 0.1–0.3 (0.6) mm long; central vein (and revolute margins) somewhat broadened (in lower third 1–2.5 times broader than revolute margins, 1–3 (4) simple hairs abreast) and only visible two-thirds of the length of the leaves. *Flowers* 1, rarely up to 5 but then in a diffuse polymonads with lateral flowers overtopping terminal one, terminal on main branches; hypsophylloids lanceolate to ovate, at least upper ones half or usually less than calyx lobes and with central vein and revolute margins not or scarcely developed. *Outer calyx lobes* ovate, usually with indistinct central vein and recurved upper margins; *inner lobes* rounded or often emarginate. *Stamens* (6-) 8–10 (-12), with inner central one longer. *Diagnostic features*: Typically cauline leaves of this variety are rarely more than 11mm long and have tightly rolled margins so that the undersurface is rarely visible, but also specimens with scarcely revolute leaf margins and short central vein have characteristic hypsophylloids usually covering only the basal half of the calyx, so that the individual flowers seem quite separate. The longer central stamen (rarely two) is often not clearly visible in dried specimens, but often the raised connective of the stamens forms a short terminal appendage, which usually distinguishes this group from "Sericea" and "Densiflora".

Variation: Cauline leaves from inland plants were usually found to have strongly revolute margins. As their hypsophylloids are usually considerably shorter in contrast to those of their counterparts from the coast, this seems to reflect more than different environmental conditions. Plants with tightly rolled leaves from more arid areas also tend to have a relatively broader central vein although this might be accentuated by their shorter leaves. However, because of the difference in the degree of recurved margins of the leaves, which affects their relative width, the characteristic of "leaves 3–5 times longer than broad" (Toelken 1996) can only be used in extreme cases.

In the southern parts of the South-Eastern Region of South Australia populations seem to show a much greater variation and the longer hypsophylloids are often associated with a strongly developed central vein in the often linear-oblanceolate leaves, which could indicate widescale hybridization with plants of "Densiflora". Records from the nearby Portland are even more revealing because most of their leaves are little recurved so that the plants (e.g. *B.G.Briggs 2935, P.C.Heyligers 80050*) superficially resemble the form of "Sericea" from south-west of Geelong, but here the hypsophylloids are few and distinctly shorter than the flowers, which are borne in loose terminal and lateral clusters.

A parallel development of a more prominent central vein and smaller as well as often fewer hypsophylloids subtending the flowers in more arid areas can be observed in *H. crinita* (form from the Flinders Ranges) and "*Scabrifolia*" group, but its significance can only be speculated on.

For each of the characters of "Scabrifolia" there are some exceptions and since many specimens from the coastal areas and especially from much of the South-Eastern Region of South Australia have a pronounced central vein up to nearly the top of the leaves, i.e. reminiscent of "Densiflora", "Scabrifolia" is probably the least clearly delineated group in *H. sericea.*

Particularly hairy forms (e. g. *M.Tindale NSW 85976*) have been recorded from the area between Bordertown and Keith, but these plants have been found to have mainly simple hairs on the upper leaf surface, so that they cannot be confused with *H. crinita.*

Voucher specimens

"Scabrifolia"

VICTORIA: *H.I.Aston 1008,* 22.4 mls N Serviceton North, 30.ix.1963 (BRI, MEL); *A.C.Beauglehole 84461,* Kiata Lowan Sanctuary, 15.ix.1986 (MEL); *R.Melville et al. 985,* 24 mls ESE Kaniva, 16.ix.1952 (MEL, NSW). SOUTH AUSTRALIA: *C.R.Alcock 5791*, summit of Mt Rescue, 5.x.1977(AD, CANB); *R.D.Hoogland 11867*, 15 mls ESE Meningie, 17.xi.1970 (AD; CANB, MEL, NSW; A, HBG, K, L, OKLA, UC, US, n.v.)

"Scabrifolia" → "Sericea"

VICTORIA: *D.E.Albrecht 1099*, ca 12 km by road west of Portland, 13.x.1984 (MEL); *A.C.Beauglehole 13544*, Castle Rock area, 6.xi.1966 (MEL); *R.V.Smith 59/245*, Anglesea, 15.x.1959 (MEL 673021).

SOUTH AUSTRALIA: *R.Bates 6122*, Waitpinga scrub, 14.ix.1985 (AD); *E.N.S.Jackson 243,* Devils Hole in Caroline Forest Reserve, 17.xi.1959 (AD).

Notes (on *H. sericea*)

Tate (1890) recorded *H. sericea* from his Port Lincoln region, but it is not clear what specimen or species he was referring to, or if he followed Bentham (1863), who had erroneously placed *H. cinerea* from that area into *H. sericea* (Toelken 1998).

"Scabrifolia" is not only a small or even depauperate form of "Sericea" because in addition to all organs being relatively smaller, the bracts immediately below the terminal flower, which are usually enhanced in that subspecies, are reduced and usually even shorter than the cauline leaves below in "Scabrifolia". It thus presents its flowers not only upwards but in all directions and could represent an entirely different pollination syndrome.

Typification

The specimen of ***Pleurandra sericea*** collected by R. Brown in Herbarium de Candolle, who attributed the name to Brown, was selected as the lectotype of this species. No Leschenault specimen (the other syntype) could be located in de Candolle's herbarium, and, since it is very unlikely that de Candolle would have annotated the specimens he had seen elsewhere, it will be difficult to prove that any Leschenault specimen found in another herbarium was the specimen examined by the author. Although some putative hybrids have been recorded from Port Phillip Bay, the type locality, the two specimens examined of the Brown type did not show any signs of hybridity.

As the original description of ***H. sericea*** var. ***scabrifolia*** is very general and Black (1925) mentioned only a distribution range instead of enumerating individual specimens examined, one has to lectotypify the taxon on whatever specimens he might have consulted. The folder of this taxon in J.M.Black's herbarium contained twelve specimens and a description of a specimen from "Mt McIntyre, near Millicent. Tate Herb." There are three such specimens in the latter herbarium but only one was inscribed *H. sericea* var. *scabrifolia* in what seems to be the author's handwriting. That specimen is mounted on the same sheet (AD 97620418) as an A.Richards' specimen of *H. platyphylla* subsp. *major* (cf notes there) from Pt Lincoln – Streaky Bay (Streaky Bay is mentioned in the protologue, see also note below), on which there is a similar identification by the author. These two specimens are included as syntypes, while a second sheet (AD 97620432), which contains another *Perrin* specimen from Mt McIntyre inscribed "H. sericea" and a second specimen from the same locality but without collector or any identification by the author, are not considered as syntypes.

The above specimen mentioning the locality Streaky Bay is not the one that had been examined by Bentham and included in the Flora Australiensis under *H. stricta* R. Br. var. *hirtiflora* Benth. of which Black obviously was aware, because he referred to this variety in the two editions of his Flora (Black 1926, 1952), although not in the protologue (Black 1925). Bentham (1863, p. 27) mentioned two specimens "from Spencer's Gulf and Streaky Bay", but only the latter is included in the syntypes because Black (1925) specifically referred to that locality.

Of the twelve specimens of the var. *scabrifolia* in Black's herbarium, two specimens, i. e. "*J.B.Cleland s.n.*, 22.i.1926" and "*E.C.Black s.n.*, x.1939" must be excluded, because they were collected after the date of publication. Also excluded are "J.M.Black without locality

or date" and the second specimen of "*J.M.Black s.n.* & ADB, 22.xi.1917, Keith" and "*J.M.Black s.n.*, 15.x.1918, S Lameroo", because they were not identified by the author.

Among the syntypes six specimens (1, 4, 5, 7, 8, 9) agree with both Black's protologue and the present concept of the taxon. The collection 7 (*J.M.Black s.n. & ADB*, Keith) with the most detailed description and illustrations including that of a seed, a good representative specimen, and a determination by J.M.Black was chosen as lectotype. (ADB probably stands for Mrs Alice Black (neé Denford) or Mrs J.M.Black. His diary (manuscript in AD) records that only the two of them went to south-eastern South Australia. The syntypes are (Sc = specimen identified here as "Scabrifolia"; Det = identified by J.M.Black):

1. *Perrin s.n.*, Mt McIntyre, near Millicent, AD 97620418 (brief description) – Sc; Det
2. *A.Richards s.n.*, Port Lincoln – Streaky Bay, x.1882, AD 97620418 (no analysis) – *H. platyphylla* subsp. *major* – Det
3. *Major Warburton MEL 35803*, Streaky Bay (no analysis) – *H. platyphylla* subsp. *platyphylla*
4. *J.M.Black s.n.*, 2.viii.1905, Tintinara, 90 Mile Desert, AD (no analysis) – Sc; Det
5. *J.M.Black s.n.*, 4.x.1906, East Wellington, AD (brief notes) – Sc; Det
6. *H.H.D.Griffith s.n.*, x.1908, Cape Borda, AD (brief description) – *H. platyphylla* subsp. *halmaturina*; Det
7. *J.M.Black s.n.* & ADB, 22.xi.1917, Keith, AD (detailed description & illustrations) – Sc; Det – Lectotype
8. *J.M.Black s.n.*, 15.x.1918, S Lameroo, AD (detailed description & illustrations) – Sc; Det
9. *J.B.Cleland s.n.*, xii.1922, Cape Bonney, Millicent, AD (brief notes) – Sc; Det

J.B.Cleland s.n., 18.x.1924, Rocky River, K.I., AD (brief description) – *H. platyphylla* subsp. *halmaturina*; Det

Specimens (see under forms): ca 420 examined.

Putative hybrids

H. cistiflora* subsp. *rostrata* × *H. sericea

The whole plant is more or less covered with simple hairs over antrorse (1–3 subequal branches mainly on leaves above) to radial stellate hairs (4–8 subequal branches on branches, upper leaves and on calyx) or only stellate hairs on the ovary. The single terminal flowers are each subtended by one leaf-like bract, and from the axils of the leaves below it further branching into more flowers results in the terminal polymonads typical of the *H. sericea* complex. The var. *sericea* is the only member of this complex growing in the vicinity and the hairs described above for the hybrid resemble that taxon. The terminal flower clusters are significant as most specimens of *H. cistiflora* subsp. *rostrata* from Mt William, in contrast to other localities in the Grampians, have their single terminal flowers mainly on axillary short shoots. The linear leaves of the hybrid have a very broad central vein to the apex (but not protruding), so that the undersurface is not or scarcely visible reminiscent to those of *H. cistiflora* subsp. *rostrata.*

Although R.D.Hoogland collected similar specimens on two occasions he did not indicate their putative hybrid nature on the accompanying label and they were identified as *H. sericea.* Another collection, *R.D. Hoogland 12438,* from the summit of Mt William, where

H. sericea normally would not grow, shows an even larger percentage of abnormal pollen, which cannot be explained. This specimen, possibly not a hybrid as it shows no abnormal features for *H. cistiflora* var. *rostrata*, and again the collector did not indicate any reasons for selecting this specimen.

Specimens examined

H. cistiflora* subsp. *rostrata* × *H. sericea

VICTORIA: *R.D.Hoogland 11716*, western slopes of Mt William, 10.xii.1969 (CANB: 13% abnormal pollen; MEL, K); *12439*, rocky slopes along Mt William Road, 1.xii.1973 (CANB: 11% abnormal pollen; A, HBG, G, K, L, MEL, UC).

H. cistiflora subsp. rostrata

VICTORIA: *A.C.Beauglehole 15935*, north-western slope, Mt William, 14.xi.1966 (MEL: 0 % abnormal pollen); *R.D.Hoogland 11714*, western slopes of Mt William, 10.xii.1969 (CANB: 3 % abnormal pollen; A, K, L, MEL); *12438*, summit area of Mt William, 1.xii.1973 (CANB: 32 % abnormal pollen; HBG, K, L, MEL: 28 % abnormal pollen).

H. sericea

VICTORIA: *M.G.Corrick 10069 & D.B.Foreman*, Wallaby Rocks, 1.xii.1986 (MEL: 0 % abnormal pollen); *R.D.Hoogland 12423*, near Golton Gorge, 15.ix.1973 (CANB, MEL: 0 % abnormal pollen).

H. sessiliflora Toelken, J. Adelaide Bot. Gard. 16: 69 (1995); in Walsh & Entwisle, Fl. Vict. 3: 308 (1996).

Type: Victoria, near Dergholm, *H.R.Toelken 8358* (holo: AD; iso: B, CANB, G, K, MEL, MO, NSW, NY).

H. stricta var. *readeri* Ewart in Ewart & Jean White, Proc. Roy. Soc. Victoria NS 21, 2: 543 (1909).

Type: Victoria, Casterton, *F.M.Reader s.n.*, 30.vii.1908 (lecto.: MEL 35752; syn.: MEL 695563, NSW 101987).

Shrublets rarely more than 0.2 m tall, with one to few short at first erect but often becoming slender decumbent wiry branches 0.1–0.5 m long, usually glabrescent. *Vestiture* usually sparse, on all parts consisting more or less of longer simple hairs (up to 0.5 mm) over small stellate hairs, and both only often on branches tubercle-based; *on stems* scattered simple hairs unlike axillary tufts over more, scattered, usually unequal, radial stellate hairs (2–6 equal branches) scarcely increasing acropetally; *on leaves above* with mainly longer simple hairs towards the margins and base over few antrorse stellate hairs (1, 2 subequal or unequal branches), rarely scattered radial stellate hairs (4–6 (-8) equal branches) on upper margins; *on leaves below* rarely with few long simple hairs on the margins and the lower central vein over usually dense radial stellate hairs (8–16 subequal branches) on the undersurface including the central vein and inner recurved margins; *on hypsophylloids*, *bracts* and *outer calyx lobes* with often coarse, few to many antrorsely inclined simple hairs over antrorse to erect stellate hairs (2–5 subequal branches); *on inner calyx lobes* with simple hairs concentrated on the central vein over/or erect to antrorse stellate hairs (2–4 (-6) subequal branches). *Leaves* with axillary tuft of hairs elongating acropetally to 0.8 mm long; *petiole* 0.2–0.6 mm long; *lamina of cauline leaves* linear-elliptic, (3.6-) 4.5–8 (-9.6) × (1.2-) 1.5–2.3 (-4.6) mm, gradually tapering into petiole, apex acute or apiculate, with one to few hairs, below with scarcely broadened central vein (ca 0.2 mm wide at the middle), hispid to stellate-tomentose, visible for two-thirds of the length and about as broad as scarcely recurved margins, with stellate-tomentose undersurface always more or less exposed; above puberulous rarely pubescent, glabrescent, discolorous; *lamina of hypsophylloids* elliptic-lanceolate to ovate, 2.1–3.5 × 0.9–1.4 mm, obtuse, with scarcely recurved margins, hardly raised central vein and widely exposed pubescent to tomentose undersurface. *Flowers* sessile, single, subtended by 3–5 hypsophylloids, terminal on short

shoots along branches but also on main branches; *bracts* like hypsophylloids. *Calyx* grey-green to often reddish-brown; *outer calyx lobes* lanceolate to ovate, 5.2–8 × 1.2–1.8 mm, outside strigose, inside few stellate hairs towards the upper margins; *inner calyx lobes* broadly ovate to oblong-ovate, 5.1–7.5 × 1.4–2 mm, acute, with bristles along the central ridge, and pubescent with simple and stellate hairs on the lateral surfaces. *Petals* obovate often with cuneate base, 3.8–9.6 (-10.7) mm long, distinctly lobed. *Stamens* (4-) 5–7 (-10), with filaments almost free; *anthers* broadly oblong, dehiscing by terminal pore and later slits. *Pistils* 2, ovary laterally compressed, each with 4 ovules, style at base recurved along the apex of ovary, then erect in front of cluster of anthers. *Fruit* stellate-tomentose to -villous. *Seeds* brown to probably shiny-black, ca 2 × 1.8 mm, fleshy aril surrounded by scarcely lobed sheath appressed to lower quarter of seed. *Flowering*: Sept.–Nov. (Dec.). Fig. 9A–I.

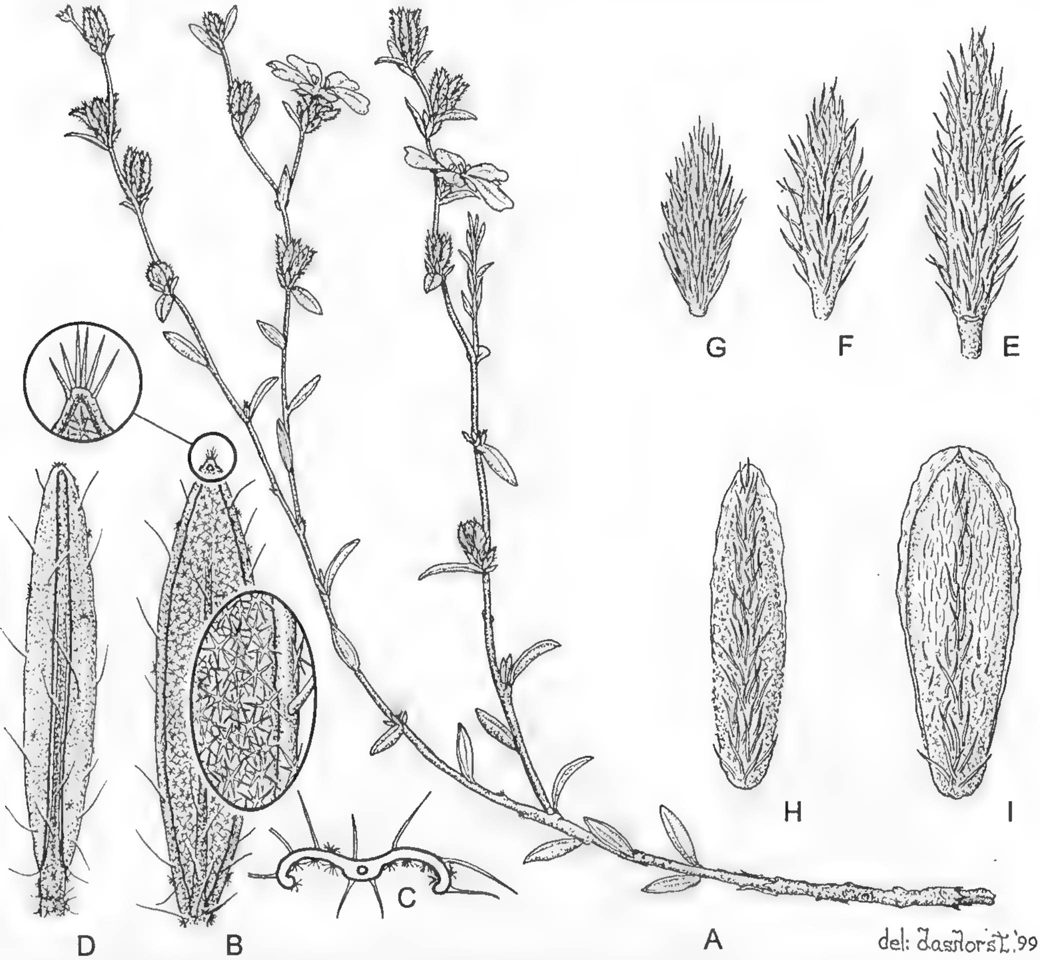

Fig. 9. ***H. sessiliflora***. A, flowering branch; B, flat cauline leaf; C, transverse section; D, cauline leaf with rolled margins; E, F, hypsophylloids; G, bract; H, outer calyx lobe; I, inner calyx lobe. (A–I, *A.C.Beauglehole 38032*, MEL; **A** ×½; **B, D, F–I** ×8; **C** ×12; **E** ×10).

Distribution and ecology

Grows on clay soil in seasonally wet heath land or bordering lakes, often surrounded by *Eucalyptus* woodland in Edenhope-Dartmoor area (WAN) in Victoria and near Naracoorte (SE) in South Australia.

Conservation status. Although locally common this species is vulnerable because it is associated with often widely separated seasonally wet heath land. 3V.

Diagnostic features

Although it superficially resembles forms of *H. sericea* it is easily distinguished by its central vein being scarcely or not at all broadened.

Variation

In contrast to other species in this complex, the leaves of *H. sessiliflora* vary very much depending on the extent to which the margins are recurved, and in extreme examples one cannot see the hardly developed central vein between the strongly recurved margins.

Notes

It is not clear whether the phylloms subtending the flowers are hypsophylloids, as here accepted, and are comparable to those in, for instance, *H. sericea*, or merely depauperate leaves on short shoots. Some flowers terminal to long shoots were found to be subtended by normal leaves as in *H. patens* and allied species.

This species resembles *H. patens* and *H. paeninsularis* in that the leaves have a terminal point with one to a few hairs when young, outer calyx lobes which are not apically recurved and the tufts of hairs between the stamens and petals absent.

Voucher specimens (20 examined)

VICTORIA: *A.C.Beauglehole 37912*, 10.5 miles WNW Casterton, on Tullich Rd, 17.xi.1971 (AD, MEL, CANB); *38122*, 5.5 miles N Dartmoor, W of Casterton Dartmoor Rd, 31.xii.1971 (MEL, CANB).

SOUTH AUSTRALIA: *D.Hunt 2191*, "Joanna", 17.x.1964 (AD, K, M, NE, CAL, TI); *J.Z.Weber 7323*, Stewart Range, 4.x.1982 (AD, CANB).

H. simulans Toelken, *sp. nov.*

H. sericea auctt. non (R.Br. ex DC.) Benth.: N.C.W.Beadle et al., Vasc. Pl. Sydney 1 edn: 196 (1963), partly; N.C.W.Beadle, Stud. Fl. NE N.S.W. 3: 255 (1976), partly; G.J.Harden & J.Everett in G.J.Harden, Fl. N.S.W. 1: 302 (1990), partly; Carolin et al., Vasc. Pl. Sydney 4 edn: 274 (1993), partly.

H. sericea Benth. var. *sericea sensu* S.W.L.Jacobs & J.Pickard, Pl. N.S.W. 110 (1981), *partly*.

A *H. sericea* pilis simplicibus in partibus omnibus et costa centrali lata foliorum confluenti margine apicale; a *H. patenti* costa centrali lata, foliis subtus invisibilibus et staminibus paucis papillosulis; a *H. puberula* ovariis villosis, habitu erecto-patenti differt.

Type: New South Wales, Mount Costigan, *E.F.Constable s.n.*, 22.x.1958 (holo.: NSW 55989).

Shrubs 0.3–0.8 (-1) m tall, with several woody erect stems, much branched, pubescent, rarely villous below flowers. *Vestiture* on all parts consisting of few long and many short spreading simple hairs, often not obviously tubercle-based and usually acropetally inclined, not becoming denser acropetally on stems but dense and usually coarse on calyx. *Leaves* with axillary tuft of hairs elongating acropetally to 0.8 mm; *petiole* 0.2–0.5 mm long; *lamina* linear-lanceolate to -triangular, (2.8-) 3.5–6 (-7.2) × 0.7–1.5 mm, apex acute and sometimes recurved but usually becoming obtuse, scarcely constricted into petiole, broadened central vein usually recessed or rarely raised to the level of the revolute margins and continued (0.2–0.6 mm broad in the middle) into or sometimes overtopping the apex, with undersuface not visible, puberulous above and below. *Flowers* single, terminal on main branches and on short shoots; *bracts* linear to linear-lanceolate, 2.3–3.5 × 0.25–0.45 mm, usually without distinct central vein and recurved margin, puberulous. *Calyx* not

accrescent; *outer calyx lobes* oblong-ovate to -lanceolate, pointed to shortly acuminate, usually without recurved margins and central vein, 4.8–7.1 × 2.2–3.1 mm, outside villous to appressed-pubescent, inside with more or less simple hairs on upper half to third; *inner calyx lobes* oblong-elliptic to -ovate, cuspidate to rounded, 4.5–6.8 × 2.5–3.0 mm, outside villous to appressed-pubescent but shorter towards the margins which tend to be ciliate, inside rarely with a few simple hairs towards the apex. *Petals* obovate to broadly obovate, 5.8–8.6 mm long, more or less slightly emarginate. *Stamens* 8–10 (-14), subequal; filaments basally connate; anthers narrowly oblong, 1.8–2.2 mm, minutely papillose, dehiscing mainly by lateral slits. *Pistils* 2; ovary almost spherical, each with 4 ovules; style from outer apex of ovary, then erect in front of clustered stamens. *Fruit* villous with simple hairs. *Seeds* not seen. *Flowers*: Sept.–Nov. Fig. 10A–F.

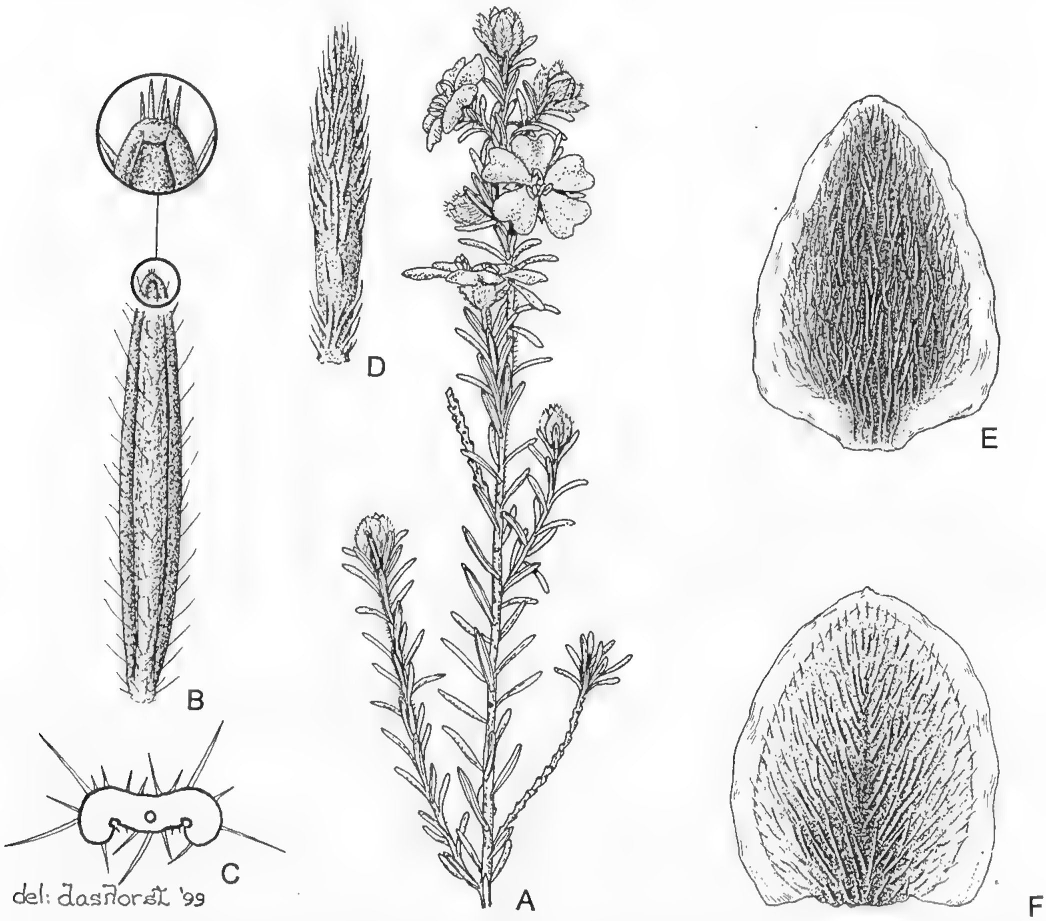

Fig. 10. ***H. simulans***. **A**, flowering branch; **B**, cauline leaf; **C**, transverse section; **D**, bract; **E**, outer calyx lobe; **F**, inner calyx lobe. (**A–F**, *E.J.McBarron 4979*, NSW101983; **A** ×½; **B, E, F** ×8; **C** ×16; **D** ×14).

Distribution and ecology

Unlike *H. patens*, which usually grows in rock crevices in ravines, the very similar *H. simulans* has been recorded mainly from scrub vegetation from tops of mountains or, for instance, Georges Plains, apparently usually growing in wetter areas in mainly south-central New South Wales (NWS, CT, ST, SWS).

Conservation status. Cannot be evaluated since the eight specimens examined were collected from widely separated localities more than 40 years ago. 3K.

Diagnostic features

The distinctly broadened central vein continues into the leaf apex and often overtops it, but this protrusion is often erect and rarely recurved similar to leaves of *H. patens*. In the latter species, unlike *H. simulans*, the undersurface is usually visible and covered with long silky hairs. The most northern record of *H. simulans* is from Warialda, although somewhat different from the southern populations, it can easily be distinguished from *H. tenuifolia* by its outer calyx lobes not having recurved margins and the villous ovaries. Only flowering material of that northern collection was available, so that it is not known whether it also has, unlike the latter species, a scarcely accrescent calyx.

Variation

Considering that this species is known only from a few localities, often quite distant from one another, it is remarkable how uniform is the species. The characteristic minutely papillose anthers are unique in this complex. Some significant variation in the shape, size and vestiture particularly on the inside of the calyx also occurs. Usually the outer calyx lobes are longer but in the case of the specimen from Woomargama the inner ones are larger. There are, however, too few specimens available to assess the significance of these variations. Also the size and shape of the bracts varies considerably from very small and with recurved margins scarcely showing to leaf-like.

Notes

This species was previously associated with *H. sericea* because of its resemblance to *H. patens*, but the single terminal flowers subtended by a bract without a distinct central vein might indicate closer affinity to *H. stricta*. It was here described because o0f its overall resemblance to *H. patens*, but more material is urgently needed. Especially so few specimens exist and the most recent ones were collected in the 1950's suggesting that the species could be endangered though its wide distribution area will hopefully prove otherwise.

Etymology

H. simulans was often combined with *H. patens* under *H. sericea* and yet it is not unlike forms in the *H. stricta* complex, so that the epithet "*simulans*", Latin, "resembling" seems appropriate.

Specimens examined

NEW SOUTH WALES: *P.Althofer 83*, Dubbo-Mendooran road, v.1946 (NSW 101960); *J.L.Boorman NSW 101979*, Georges Plains, 25.xi.1918 (NSW); *E.F.Constable NSW 55989*, Mount Costigan, 22.x.1958 (NSW); *Y.W.Dwyer* NSW 101982, Yass, 22.ix.1911 (NSW); *E.J.McBarron 4979*, Tunnel Road, Woomangama, 2.x.1950 (NSW 101983– 2 sheets); *J.H.Maiden NSW 101958*, Box Point to Barbers Creek, 10.ix.- (NSW); *C.W.E.Moore 2688*, Peelwood to Tuena, 15.x.1953 (NSW); *H.M.R.Rupp NSW 101966*, Warialda, vii.1905 (NSW).

H. superans Toelken, *sp. nov.*

H. sericea auct non (R.Br. ex DC.)Benth.: G.J.Harden & J.Everett in G.J.Harden, Fl. N.S.W. 1: 302 (1990), partly.

H. crinitae similis sed ovario villoso pilis simplicibus, stylo apicale, seminibus oblong-obovoideis; ab *H. simulanti* ramis debilibus et tomento brevi densissimo sub piles simplices longissimos sericeos differt.

Type: New South Wales, Kellyville, Green Road, *J.Turner s.n.*, 14.xii.1998 (holo.: AD; iso.: G, K, MEL, MO, NSW, NY, PERTH).

Low spreading shrubs to 0.3 m high, with few to many, weak twisted stems and branches, villous when young, becoming tomentose with longer hairs more or less wearing off. *Vestiture* on all parts consisting of more or less long silky over a dense layer of usually short stiffly erect simple hairs, but particularly on the branches and the undersurface of leaves there are often some scattered stellate hairs with 2–3 (-5) equal erect branches (cf. variation below). *Leaves* (none modified into hypsophylloids) with axillary hair tuft below flowers 1–1.2 mm long; *petiole* 0–0.2 mm long; *lamina* linear, rarely linear-elliptic, (5.6-)7.5–10 (-12.3) × 0.9–1.2(-1.4) mm, acute, often becoming obtuse, scarcely constricted into petiole, slightly broadened central vein usually raised to same level as revolute margins and continued (0.4–0.6 mm wide in the middle) into the apex, with undersurface not visible, villous over or becoming tomentose above and below. *Flowers* single, sessile to slightly stalked, terminal on main branches or rarely on short shoot, younger ones freely overtopping older ones; *bracts* linear, 8.3–9.5 × 1.0–1.3 mm, like leaves with distinct central vein, villous sometimes becoming tomentose. *Calyx* not accrescent; *outer calyx lobes* linear-lanceolate, acute, with slender central vein and recurved margins in upper third, (6.8-) 7.5–9 (9.8) × 1.5–1.6 mm, much longer than inner ones, outside villous over or becoming tomentose, inside at least upper half like outside; *inner calyx lobes* oblong-elliptic to –obovate, obtuse to rounded, 4.2–6.5 (-7.6) × 1.9–2.7 mm, outside villous over more or less appressed pubescent, inside rarely with a few appressed hairs towards the apex. *Petals* broadly obovate, 5.5–6.7 mm long, emarginate. *Stamens* 6–9, subequal; filaments basally connate, but often some more than others; anthers narrowly oblong, (1.4-) 1.6–1.8 mm long, dehiscing mainly by lateral slits. *Pistils* 2; ovaries laterally compressed, each with 4 ovules; style from outer apex of ovary, curved outwards and around the cluster of stamens to end at the apex of the outer anthers. *Fruit* villous with very dense erect simple hairs. *Seeds* oblong-obovoid, often oblique, 1.5–1.7 × 1.1–1.4 mm, fleshy aril expanding into a scarcely lobed sheath adpressed to the base of seed, often to one side of base of seed. *Flowering*: July–Dec. Fig. 11A–F.

Distribution and ecology

Has been recorded from sandy soil on sandstone, associated with wide range of other plants in woodland or shrub of Sydney Sandstone Ridgetop Woodland in the southern locality; on granite associated with shrubland of *Prostanthera scutellarioides*, *Themeda australis*, *Pomaderris lanigera*, *Grevillea linsmithii* and *Micrantheum ericoides* in the north near Mt Boss in New South Wales (NC, CC).

Conservation status: Although known from two widely separated localities the species is never common. In the north it is described as "locally occasional" while in the southern locality less than 1000 plants were by the collectors. 3K.

Diagnostic features

Although *H. superans* obviously has an affinity with *H. crinita,* because of a similar indumentum of dense uniformly long hairs under few longer ones, and a central vein visible to the apex of the leaf, it is distinguished by its villous ovary with long simple hairs, the terminal attachment of the style, and particularly narrowly oblong-obovate seeds with more or less distinctly laterally placed aril, which is unusual in the whole *H. sericea* group. The dense short hairs on the whole plant are predominantly simple and in particular those on the central vein of all leaves are in contrast to *H. crinita* with 1–3(4) branches. Also the short hairs on the calyx in particular the outer lobes have 1, 2 (3) branches while in *H. crinita* they have (5-) 8–25 very short branches of pulvinate stellate hairs.

Variation

Since the species is known only from three records the amplitude of the variation of the species is not known. The description is largely based on the type specimen which has consistently nine stamens, as also in *O.D.Evans & D.Blaxell NSW101924* from nearby, but *D.Binns 314* is distinguished by only six shorter anthers. This shows that the widely separated populations could be expected to show considerable variation, but, similar to other simple haired species in this complex, *H. superans* is quite distinct from the very variable *H. crinita*. Even the presence of stellate hairs in this species could have developed independently, because the short erect simple hairs are very close to one another and every now and then two or three form a 'stellate hair' with varying amount of basal fusion (cf. indumentum).

Etymology

The single successively overtopping flowers found on old flowering branches of this species are not unique in the *H. sericea* complex, but are so obvious that the epithet "*superans*", Latin, "overtopping" seems fitting.

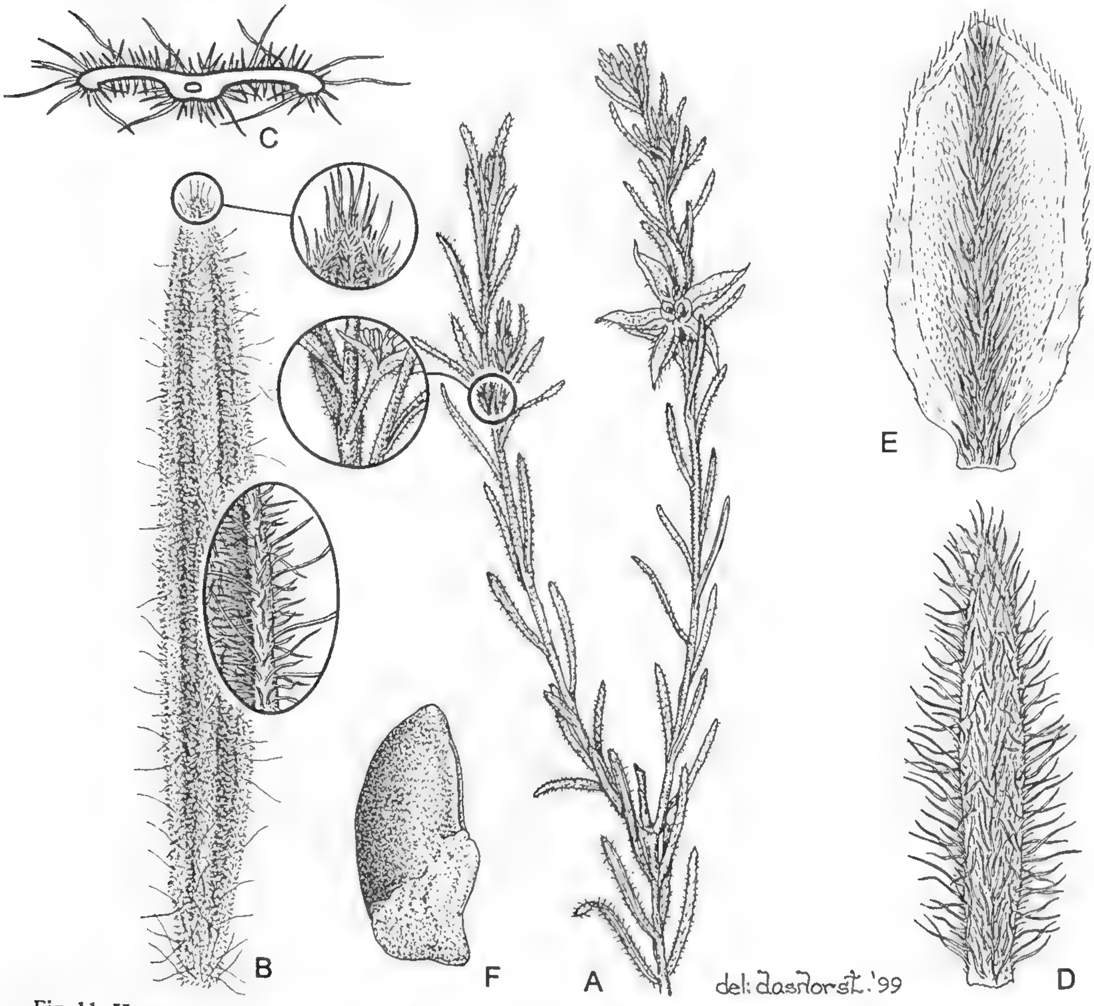

Fig. 11. ***H. superans***. **A**, flowering branch; **B**, cauline leaf; **C**, transverse section; **D**, bract; **E**, inner calyx lobe; **F**, narrowly obloid seed. (**A**–**F**, *J.Turner s.n.*, AD; **A** ×1; **B, D, E** ×10; **C** ×25; **F** ×20).

Specimens examined

NEW SOUTH WALES: *D.Binns 314*, Mt Boss, 19.vii.1988 (NSW); *O.D.Evans & D.Blaxell NSW 101924*, Annangrove, 9.x.1958 (NSW); *J.Turner s.n.*, Kellyville, 9.ix.1998 (AD, G, K, MEL, MO, NSW, NY, PERTH).

H. tenuifolia Toelken, *sp. nov.*

H. stricta var. *canescens auct. non* Benth.; Benth., Fl. Austral. 1: 27 (1863), partly as for *C.Stuart*, New England (MEL 35790 – Benth. *vidit*; MEL 35789, 35791).

H. cistoidea auct. non (Hook.) C.T.White: C.T.White, Proc. Roy. Soc. Queensl. 57: 21 (1946), partly as for *C.Stuart*, New England (as above).

H. simulanti et *H. patenti* similis sed habitu decumbenti, margine recurva loborum externorum calycis, antheris latis et ovariis tomentosis differt.

Type: Queensland, Darling Down, between Wyberba and Wallangarra, *L.Pedley 1596*, 31.x.1963 (holo.: NSW; iso.: BRI, n.v.; MEL).

Decumbent shrublets to 0.2 m high, with wiry branches little branched, pilose to pubescent. *Vestiture* on all parts consisting of a mixture of long and short simple hairs, scarcely tubercle-based, usually antrorsely inclined or on calyx antrorsely curved. *Leaves* with axillary tufts of hairs elongating acropetally to 0.7 mm long and continued laterally of the base of the petiole; *petiole* 0.1–0.4 mm long; *lamina of cauline leaves* and *hypsophylloids* linear, rarely linear-lanceolate 4.1–7.5 (-9.2) × 0.6–0.9 mm, acute becoming rounded, scarcely constricted into the petiole, with broadened central vein (0.2–0.3 (-0.4) mm wide in the middle) rarely raised to the level of the recurved margins and continued into a not individually tufted apex, pubescent to almost scabrid, with undersurface rarely visible. *Flowers* single, terminal usually on main branches; *bracts* linear, 4.3–5.4 × 0.6–0.7 mm, leaf-like with recurved margins and raised central vein, pubescent. *Calyx* distinctly accrescent; *outer calyx lobes* lanceolate to linear-lanceolate, 8.2–12.5 × 2.1–3.4 mm, pointed but not usually acuminate although with recurved upper margins, outside usually villous with antrorsely curved simple hairs, rarely appressed-pubescent; inside one-third to half covered with longer and shorter spreading hairs; *inner calyx lobes* oblong-elliptic to -lanceolate, acute to more or less pointed, 5.8–7.7 × 2.2–2.9 mm, outside villous to appressed-pubescent along the central vein becoming puberulous to glabrous along the margins, inside glabrous. *Petals* obovate-cuneate, 7.8–10.4 mm long, distinctly emarginate. *Stamens* 12–16, subequal; filaments more or less basally connate; anthers oblong to broadly oblong, 1.4–1.7 mm long, dehiscing by apical pore and lateral slits. *Pistils* 2, each oblong-obovoid and slightly laterally compressed, with 6–8 ovules; style base scarcely recurved, style from the outer edge spreading to erect in front of clustered stamens. *Fruit* tomentose with short spreading simple hairs. *Seeds* dark to mid brown, obloid, 1.8–2 × 1.2–1.4 mm, aril a fleshy ring expanding below the seed into a scarcely lobed collar around the basal but lateral attachment. *Flowering*: Oct.–Dec. Fig. 12A–I.

Distribution and ecology. Queensland (DD); New South Wales (NT).

Conservation status. Poorly known from three specimens collected in 1860s and 1870s from 'Tenterfield' or 'New England' in New South Wales, and one collected in 1963 from adjoining Queensland. 2K.

Diagnostic features

H. tenuifolia resembles *H. simulans* and *H. patens* but is distinguished by its decumbent habit, distinctly recurved margins of the prominently accrescent outer calyx lobes, broad anthers and tomentose (not villous) ovary.

Variation

The few specimens examined showed little variation.

Typification

Since Bentham (1863) cited similarly Stuart specimens under both *H. stricta* var. *canescens* and var. *hirtiflora* and two specimens (MEL 35789, 35790) found were initialled by him but not identified, the synonymy is at present not clear. Here they are both included under the latter because it is described as "leaves nearly as in var. *canescens*" but " calyx usually large [accrescent], ... and hirsute with spreading hairs", but a lectotypification of var. *hirtiflora* can only be attempted in conjunction with a revision of the *H. stricta* complex.

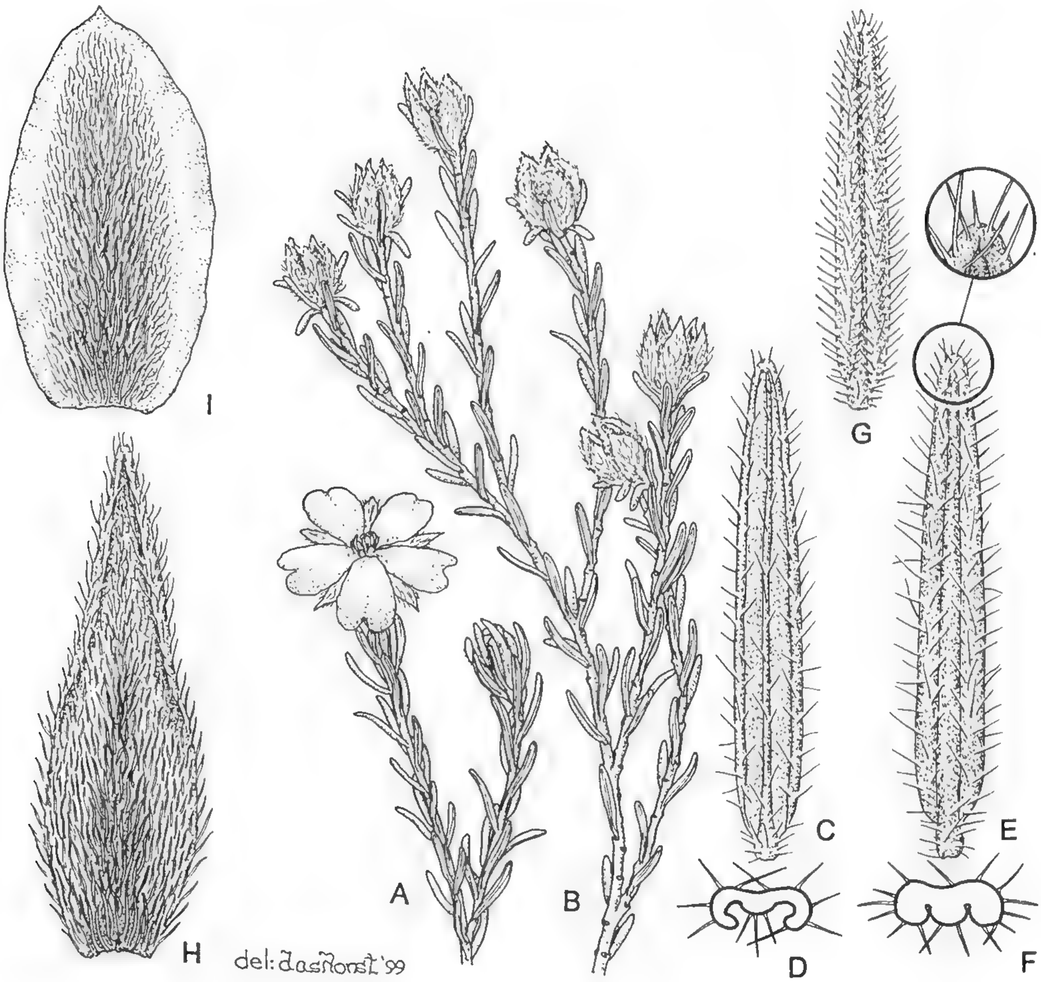

Fig. 12. ***H. tenuifolia***. **A**, Flowering branch; **B**, fruiting branch with large accrescent calyx; **C**, flat cauline leaf; **D**, transverse section; **E**, cauline leaf with strongly rolled margins; **F**, transverse section; **G**, bract; **H**, outer calyx lobe; **I**, inner calyx lobe. (**A**,**C–I**, *C.Stuart MEL35791*; **B**, *C.Stuart MEL35790*; **A–B** ×1; **C**, **E** ×9; **D**, **F**, **G** ×12; **H** × 6; **I** ×8).

Both these specimens, as the third specimen (MEL 35791) was collected in 1870, have different inscriptions so that each is presumably a single specimen of two different collections. The two specimens of *L.Pedley 1596* were selected as type.

Etymology

The species' "slender leaves", in Latin, "*tenui-folia*" explain the choice of the epithet.

Specimens examined

QUEENSLAND: *L.Pedley 1596*, between Wyberba and Wallangarra, 31.x.1963 (MEL, NSW).

NEW SOUTH WALES: *C.Stuart MEL 35789*, New England ("Pleurandra or Hibbertia 273"); *MEL 35790*, New England (" Hibbertia? – procumbent - branchlets ascending - 1500 ft"); *MEL 35791*, Tenterfield ("Hibbertia humifusa? FM - Tenterfield Decr/70").

H. villifera Tepper ex Toelken, *sp. nov.*

H. sericea auct. non (R.Br. ex DC.)Benth.: Tate, Handb. Fl. Extratrop. S. Austral. 14, 205 (1890), partly, as for Tepper specimen from Kangaroo Island.

H. sericea var. *major auct. non* J.M.Black; J.M.Black, Trans. Proc. Roy. Soc. South Australia 49: 274 (1925), partly; Fl. S. Austral. 1 edn, 3: 386 (1926), partly; Fl. S. Austral. 2 edn, 3, 575 (1952), partly, as for Tepper specimen from Kangaroo Island.

H. sericeae et *H. platyphyllae* persimilis sed costis centralibus foliorum et hypsophylliodearum non visibilibus ad apices, paginis abaxillaribus foliorum tectis pilis stellatibus parvis sub magnes (non coactis uniformibus) stylisque plerumque rubris differt.

Type: South Australia, Kangaroo Island, W of Vivonne Bay, *H.R.Toelken 9177*, 14.x.1997 (holo.: AD; iso.: BRI, CANB, K, L, MEL, MO, NY, PERTH).

Shrubs 0.2–0.6 m tall, with one to few erect, rarely spreading stiffly woody branches, little branched, villous, sometimes becoming more or less glabrescent. *Vestiture* on all parts consisting of long simple hairs (up to 2.4 mm long) over small stellate hairs, both usually distinctly tubercle-based (often like 'goose bumps') and becoming more dense and often larger acropetally; *on branches* simple hairs similar to the axillary tufts in leaf axils concentrated along the depression on either side of the decurrent leaf bases over small multiangulate stellate hairs (5–8 (-15) subequal branches) increasing in number and size acropetally (3–6 often unequal branches); *on leaves above* with mainly long simple hairs towards the margins and base over few antrorse stellate hairs (1,2 subequal or unequal branches) increasing mainly in number but also with (2) 3–5 antrorse to spreading subequal branches; *on leaves below* with long simple hairs along the margins and visible central vein over usually dense multiangulate stellate hairs (8–15 subequal branches) on the undersurface including the central vein, often a number of them on the upper leaves enlarge (>25 subequal branches) and usually broaden the base over the normal stellate hairs; *on hypsophylloids* and *outer calyx lobes* antrorsely inclined simple hairs over antrorse to erect stellate hairs (2–5 subequal branches); *on inner calyx lobes* with few simple hairs and/or larger erect stellate hairs (2–4 branches) mainly along the main vein over short multiangulate stellate hairs (3–6 subequal branches). *Leaves* with axillary tuft of hairs elongating acropetally up to 2.1 mm long; *petiole* 0.3–1.1 mm long; *lamina of cauline leaves* linear-elliptic to rarely linear-oblanceolate, (6-) 9–14 (-18.8) × (1.4-) 2.1–3 (-3.6) mm, gradually tapering into petiole, acute often becoming obtuse, with somewhat broadened raised central vein (0.28–0.49 mm wide in the middle) villous to stellate-tomentose, visible to just below the leaf apex and usually broader or as broad as the revolute margins, with stellate-tomentose undersurface always visible, above villous becoming glabrescent, discolorous; *lamina of hypsophylloids* linear-lanceolate, rarely linear-elliptic, (6-) 9.5–12 (-13.7) × 1.4–2.2 mm, scarcely tapering into petiole and acute apex, with broadened raised central vein (0.4–0.95 mm wide in the middle), villous to stellate-tomentose and visible to just below the leaf apex and usually broader or as broad as

the revolute margins and exposed undersurface, like cauline leaves but somewhat narrower and acute. *Flowers* sessile, (2-) 3–5 (-12) in terminal cymbiform polymonads, subtended by few to many hypsophylloids, in terminal globular clusters on main and lateral branches, rarely elongated due to a number of clusters from short shoots below; *bracts* linear-lanceolate, 3.3–4.5 mm long, flat and usually with margins and broad central vein scarcely raised, villous. *Calyx* usually turning reddish-brown, scarcely accrescent; *outer calyx lobes* lanceolate, 4.8–5.5 × 2.2–2.6 mm, acute to pointed, scarcely recurved apically, villous, inside glabrous with a few stellate hairs towards the upper margins; *inner calyx lobes* oblong-ovate to obovate, 4.7–5.5 × 2.8–3.3 mm, acute to obtuse, stellate-tomentose with few long simple hairs. *Petals* obovate, often with a cuneate base, 5.6–11.3 mm long, distinctly bilobed. *Stamens* 7–11, with filaments basally connate; *anthers* linear, 1.6–2 (-2.3) mm long, subequal or with central one slightly longer, dehiscing by terminal pore and lateral slits. *Pistils* 2, slightly compressed, with 4 ovules, style base recurved along the apex of ovary and stellate-tomentose, style usually becoming red. *Fruit* stellate-villous to -tomentose. *Seeds* brown to shiny black, ca 2 × 2 mm, aril with fleshy ring surrounded by scarcely lobed sheath appressed to base of seed. *Flowering*: Sept.–Nov. Figs. 1A, B; 13A–H.

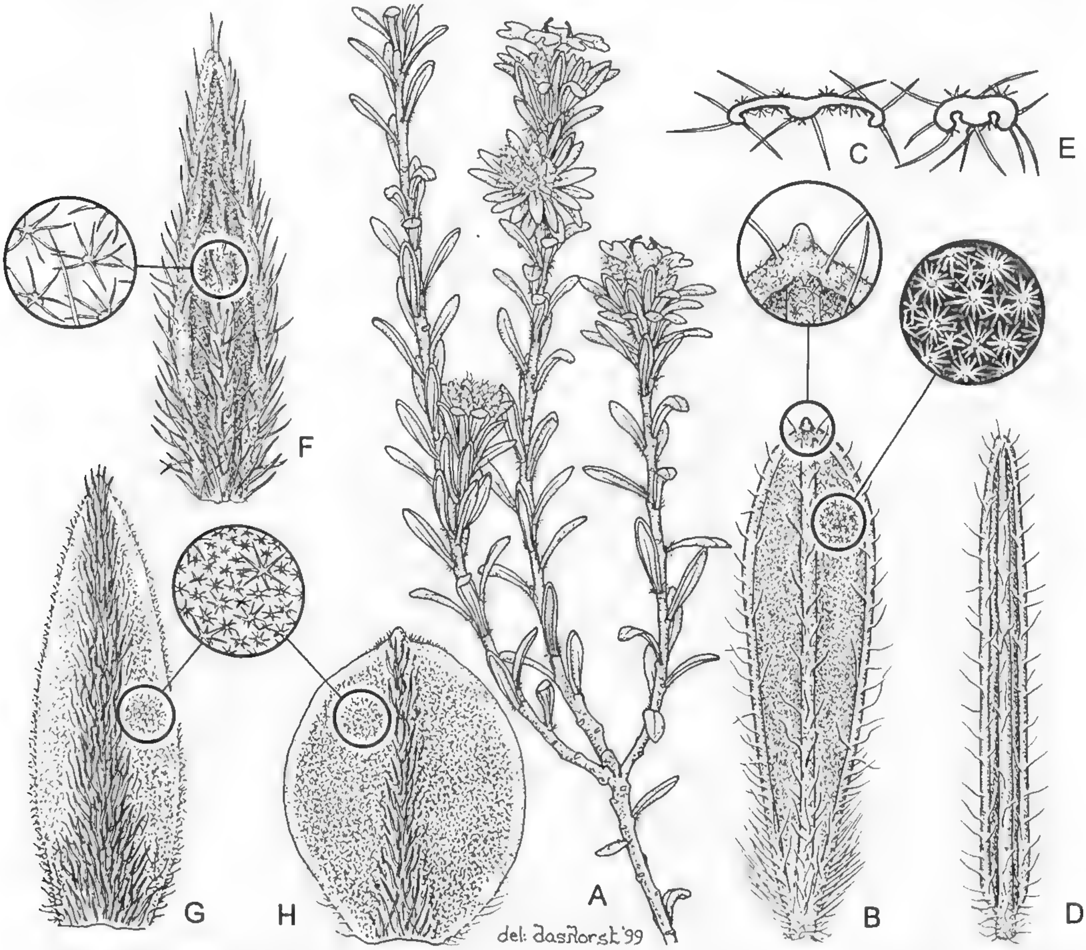

Fig. 13. *H. villifera.* **A**, flowering branch with scar of previous cluster of flowers at branching point; **B**, flat cauline leaf showing on undersurface larger over smaller stellate hairs; **C**, transverse section; **D**, cauline leaf with rolled margins; **E**, transverse section; **F**, hypsophylloid/ bract; **G**, outer calyx lobe; **H**, inner calyx lobe. (**A–H**, *H.R.Toelken 9225*; **A** ×½; **B, D** ×6; **C, E–H** ×8).

Distribution and ecology

Scattered and not common on dry sandy or lateritic soils rarely with surface limestone locally associated with heath or mallee in South Australia (SL, KI).

Conservation status. Although the species occurs on the mainland and on Kangaroo Island it is never common but found in several parks in both parts of its distribution. 3RCa.

Diagnostic features

The rigidly woody stems, long silky simple hairs over more or less developed short stellate hairs on the upper surface of leaves, and flowers fascicled in terminal polymonads resemble those of *H. platyphylla* subsp. *major*. However, *H. villifera* is distinguished by the central vein being visible to just below the apex of leaves and hypsophylloids, the outer calyx lobes only half covered with hairs on the inside, 7–11 stamens and red styles. Superficially depauperate plants often resemble those of some forms of *H. platyphylla* var. *halmaturina* except that in that taxon the central vein continues to the apex, the flowers are rarely clustered and are surrounded by leaves, and the styles are yellow.

H. villifera is also very similar to *H. sericea*, particularly to the "Densiflora" which shares the more or less oblong leaves, the pronounced central vein almost to the apex, and styles often become red during flowering. But the former is distinguished by its mainly terminal polymonads, the long silky simple hairs (1.8–2.4 mm long), which are sparse on the central vein (1 or 2 abreast), the larger over smaller stellate hairs on the undersurface of particularly the acropetal parts of cauline and especially leaves below the terminal polymonads, and the typical substrate of dry sandy or lateritic soils.

Variation

The oblong leaves have marginally often strongly recurved to rolled so that especially the upper ones become linear and more or less pointed.

The larger stellate hairs with broad base and numerous branches are not found on all leaves subtending flowers of all plants, apart from the fact that they are often not visible because the leaves are so strongly recurved.

Notes

The first specimens of this species were collected by J.G.O.Tepper near Karatta on 10.xi.1886 (MEL 35704, inscribed "Hibbertia villifera", as presumably the collector considered it to be distinct) and 16.xi.1887 (AD). It seems Black (1925, 1926, 1952) based his record of *H. sericea* var. *major* from Kangaroo Island on this collection as he described the "sepals very silky" which also applies to this species and not to other specimens of *H. platyphylla* in the area. In the original description Black (1912) referred only to type specimen from Port Lincoln.

Etymology

The epithet "*villifera*", Latin, "*villi*" "long weak hairs", "*-fera*" "bearing" refers to the presence of long thin hairs particularly on the leaves, which distinguish this species from *H. sericea*, the only other species known to Tepper at the time.

Voucher specimens (46 examined)

SOUTH AUSTRALIA: *H.Eichler 15147*, at the Shackle, 3.xi.1958 (AD, CANB); *P.Martensz 312, 324, 426*, Kangaroo Island, 2/3.x.1970 (AD, CANB, K, L); *D.E.Murfet 827*, near Ashburn, 9.ix.1989 (AD); *A.G.Spooner 10856*, Cox Scrub, 3x.1987 (AD).

Putative hybrid

H. paeninsularis × *H. villifera*, see *H. paeninsularis*.

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A grant from the Helen Leitch Foundation assisted in creating a databank of the South Australia specimens of *Hibbertia* for research on endangered species. Interstate collecting and field studies of these species were made possible by a grant from ABRS. I also acknowledge the loan of a great number of *Hibbertia* specimens from CANB, BRI, HO, K, MEL and NSW.

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Correction

In the treatment of *Hibbertia appressa* in Toelken (1998) no Latin diagnosis and type were included in the description. The following is published to validate here the name of this new species:

H. appressa Toelken, *sp. nov.*

H. appressa Toelken, J. Adelaide Bot. Gard. 18, 2: 120 (1998), *nom. inval.*

H. empetrifoliae similis sed pilis simplicibus adpressis praecipue ad basim calicis, pilis simplicibus in fructu et 8–12 staminibus differt.

Type: Victoria, western slope of Mt Elizabeth 2, *R.D.Hoogland 11912*, 26.11.1970 (holo.:MEL!; iso.: A, CANB, G, HBG, K, L, UC, n.v.).

J. Adelaide Bot. Gard. 19: 55–73 (2000)

DIVERSITY IN *ACAENA* (ROSACEAE) IN SOUTH AUSTRALIA

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Abstract

Numerous population samples of *Acaena* in South Australia have been examined. In South Australia three species, *A. echinata* Nees, *A. ovina* A. Cunn, and *A. novae-zelandiae* Kirk, and the hybrid *A.* x *anserovina* Orchard have been recognised. The diversity of morphological characters within these samples indicates that the maintenance of varietal names is not supported. *Acaena ovina* and *A. echinata* are both variable species and a multivariate analysis indicated that these taxa tend to differ in a number of characters but still show some degree of overlap.

Introduction

Acaena is a genus is of perennial herbs either tufted or stoloniferous, slightly woody at the base, the leaves are imparipinnate, the leaflets mostly lobed or toothed, the flowers are small, more or less sessile, clustered in heads or interrupted spikes, petals are absent and the solitary carpels produce an achene enclosed in a spiny hypanthium. The plants are protogynous, Dawson (1960), wind pollinated and likely to be strongly outcrossing.

The genus belongs to the family Rosaceae s.l. and to the subfamily Rosoideae or to the Rosaceae s.str. if the several segregate families are removed.

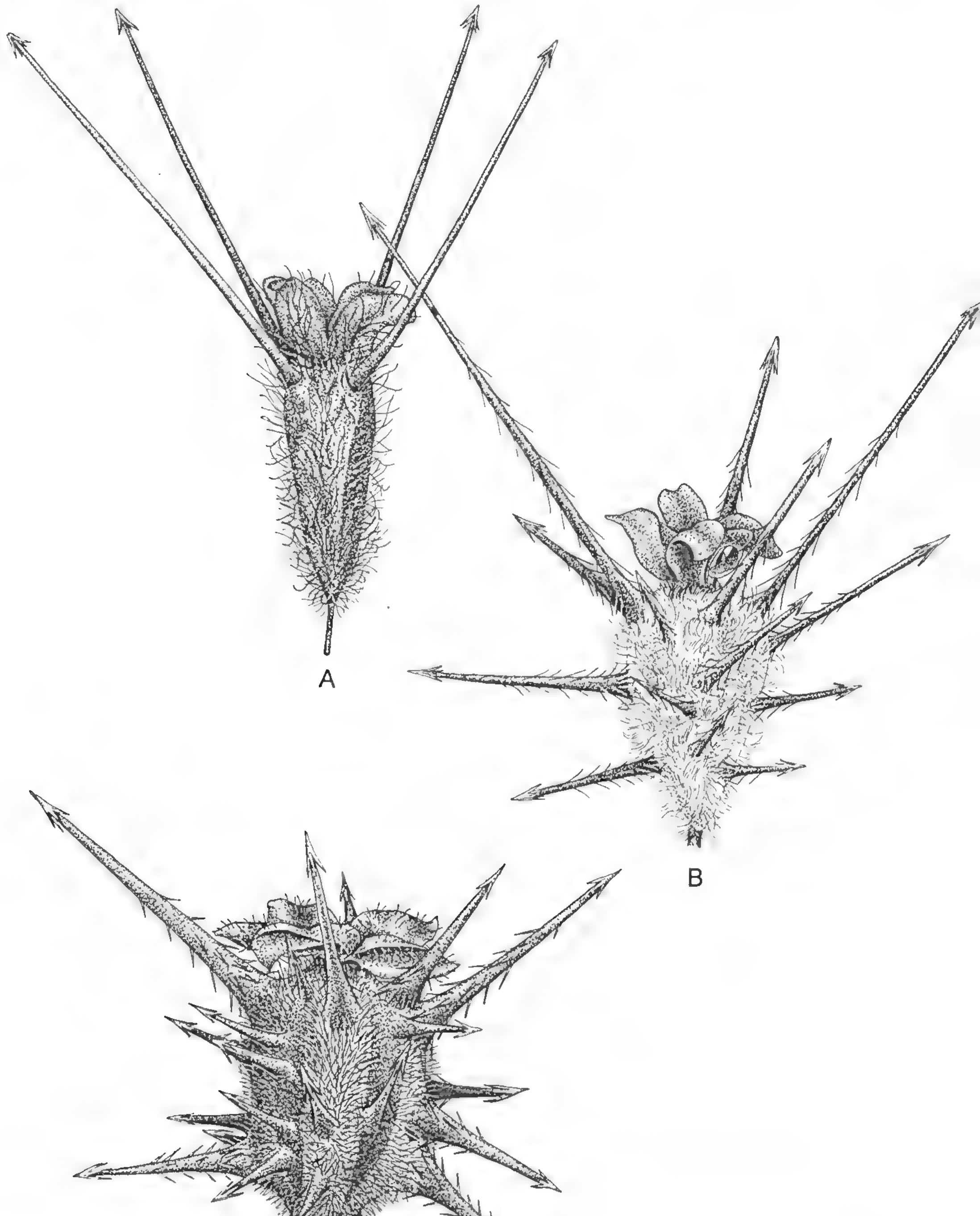
Acaena occurs in all Australian states except the Northern Territory. It is widespread in New Zealand and South America with one or two species in Africa and is thus mainly Southern Hemisphere in distribution. One species has become established in Europe.

The plants occur in grassland, light woodland, coastal dunes and only in areas with moderate to good rainfall. They do not occur in our arid or tropical regions.

The barbed fruits (Plates 1–3) which are readily detached are ideal for transport by man or beast Ridley (1930), Kok (1975), Culwick (1982), Monillo and Brener (1993), Dean et al. (1994), and it is probable that their distribution in Australia is a dynamic one. While *A. novae-zelandiae* was collected from the southern Lofties by F. Mueller and from Kangaroo Island by R. Brown, it was not collected from Eyre Peninsula until 1967 or from York Peninsula until 1969. The genus is represented in Western Australia by *A. echinata* only. This taxon was collected in 1839 soon after white settlement. Certainly the environment of the south west of Western Australia is suitable for other species. One Australian species is now naturalised in New Zealand, *A. agnipila* sensu Orchard (1973), and *A. echinata* is only known there from one ephemeral collection in 1942. The Australian species *A. agnipila* has become a serious weed in New Zealand, Macmillan (1995) pers. com. In Britain *A. novae-zelandiae* has become established, Gynn and Richards (1985).

A Northern Hemisphere parallel of *Acaena* would seem to be *Sanguisorba*, 1–2 species of which are naturalised in Australia (see below).

In keys and floras the genus *Acaena* is usually first divided into species with globose heads and those that are spicate or with fruits below a globose head. The name *Acaena novae-zelandiae* is widely used for the most common of the globose-headed species in Australia, with possibly three other globose-headed *Acaena* species: *A. montana* in


A
B
C
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Tasmania, *A. pallida* in Tasmania and New South Wales and *A.* sp. *A* Harden & Rodd in alpine New South Wales. The spicate flowered species however are not readily defined.

Hybrids between the globose and spicate-headed species have been recognised as *A.* × *anserovina* Orchard (1969). This has been characterised, in part, as having a globular head of flowers with some flowers on the scape below. Many collections of *A. echinata* have been misidentified as hybrids as this species frequently has its spike terminated by a distinct ball of flowers. Dawson (1960) in New Zealand indicated a degree of fertility in the hybrids while Orchard (1969) states that his in South Australia were all sterile. The hybrids occur frequently when the appropriate species are present and can be recognised by the well developed apical spines on the fruits with a few weaker spines below them (Plate 1), the few flowers below the globular head, the generally branched spreading stems and at times by their hybrid vigour.

The number of spicate-headed species is debatable. Orchard (1969) in the most recent Australia wide revision discussed three species, *A. agnipila* Gand. with four varieties, *A. echinata* Nees with five varieties and *A. ovina* A. Cunn. with two varieties.

Experience with the genus elsewhere from South Australia and major papers are indicated below.

Bitter (1911) monographed the genus *Acaena*. He named many new species and subspecific taxa. Bitter was a meticulous worker but had an inconsistent species concept, manifest also in his later work on the Solanaceae. Yeo (1973) says of this monograph that "there seems to be marked inequality in the variation allowed within species, some of them being very wide and embracing numerous subspecies, others being narrow and having the appearance of only minor variants."

Cockayne & Allan (1934) recorded 12 hybrids in the flora of New Zealand and stated *inter alia* "sowing seeds of suspected hybrids has always in our experience produced diverse offspring quite resembling forms occurring in nature," "the [hybrid] swarms are widespread and of great diversity," "large hybrid swarms," and "every transition in the hybrids occur". Dawson (1960) analysed and recorded hybrids in the vicinity of Wellington, New Zealand and stated such hybrids occurred in various other localities.

Allan (1961) in his Flora of New Zealand followed Bitter (1911) closely. He maintained 14 species and many varieties. All the native New Zealand species have capitate inflorescences and he finishes his treatment with a half page account of hybridism. He tells of frequent hybrids and complex hybrid swarms.

Grondona (1964) revised the species in Argentina. He maintained 20 species and reduced many earlier specific and subspecific names to synonymy.

Orchard (1969) published a revision of the *A. ovina* complex in Australia and maintained 11 varieties in 3 species. He stated "*Acaena* is well known for hybridisation at all taxonomic levels" ... "In fact *A. ovina* s.str. and *A. echinata* var. *subglabricalyx* are probably hybrid in origin, resulting from recent contact between *A. echinata* and *A. agnipila*. Other varieties within these latter two species also grade into each other to some extent" and later "During this period of expansion and diversification the original colonising species seems to have disappeared".

Walton & Greene (1971) in a study of *Acaena* on South Georgia island accepted two species, *A. decumbens* and *A. tenera,* with hybrids between them common. Both pollen fertility and seed germination of the presumed hybrids were measurably less than for either

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Plate 1. Fruit (×10). **A**, ***Acaena novae-zelandiae*** (*Symon 15220*, plant 5); **B**, ***A ×anserovina*** (Symon 15220, plant 9); **C**, ***A. echinata*** (Symon 15220, plant 10).

parent. Of general interest was the note that pilosity of leaves varied greatly even within one species, and that dioecious heads were found in *A. decumbens.* They noted that hermaphrodite heads might be replaced by female heads as the season advanced, and that stigma characters could be useful in determining species.

Yeo (1973) in discussing the species of *Acaena* with globose heads grown in Britain speaks of the "striking diversity in the colour and texture of the leaflets in *Acaena*" and under *A. magellanica* states "While the taxonomic problem is undoubtedly difficult, the morphological range these binomials represent is so enormous that one feels it ought to be possible to do something better than just lump the lot ...".

Orchard (1973) revised the *A. ovina* complex in New Zealand. He considered them all introduced from Australia. He recognised a single collection of *A. echinata* amongst "abnormal forms of *A. agnipila* v. *aequispina.* It is possible some introgression may have taken place, though none of the plants can be referred with certainty to *A. ovina* s.str." As well he found *A. agnipila* with 3 varieties largely overlapping in distribution. He also recognised *A.* × *anserovina.* His concept of this hybrid was that it included crosses with three globular headed species, *A. anserinifolia, A. novae-zelandiae* and *A. microphylla*, with both *A. agnipila* and *A. echinata.*

Walton (1975) further reduced many South American species names to synonymy. He says of Yeo (1973) "that he (Walton) saw a much wider range of specimens ... [these] ... show a complete intergradation between the characters he uses to delimit his species".

Macmillan (1983, 1985, 1991a, 1991b) raised one of Bitter's subspecies to species rank and described 5 more species from New Zealand.

Gynn & Richards (1985) wrote a biological account of *A. novae-zelandiae* now naturalised in Britain.

In the more recent *Flora of New Zealand*, Macmillan in Webb et al. (1988) listed 15 species with few varieties, including naturalised *A. agnipila* with 3 varieties and the rare occurrence of *A. echinata,* both as aliens from Australia.

Recent floras of the Australian states (or larger parts of them) have treated the genus differently, Curtis (1956), Willis (1972), Curtis & Morris (1975), Stanley & Ross (1983), Jessop in Jessop & Toelken (1986), Bennett in Marchant *et al.* (1987), Harden & Rodd in Harden (1990), Jeanes & Jobson in Walsh & Entwisle (1996). Several authors mention varieties but only Jessop describes them and only Stanley & Ross provide a key to them.

These accounts imply, perhaps, a caution in accepting many taxa of subspecific rank.

In the collection at AD a number of specimens with a globular head of fruits with several fruits on the stem below have been called *A.* ×*anserovina.* This character alone is not sufficient to indicate hybridity. An examination of three populations on Kangaroo Island (*Symon 15152; 15153; 15154*) showed plants uniform for this character though neither of the presumed parents *A. novae-zelandiae* and *A. ovina* s.l. were found locally. Most of these plants formed close rosettes with no evidence of stolons nor of the shiny green leaves characteristic of *A. novae-zelandiae* common elsewhere on the island. Using Orchard's (1969) key these all appear to be forms of *A. echinata* var. *retrorsumpilosa.* Many other collections of this taxon in AD, some identified by Orchard, bear a globular terminal head with scattered flowers below it.

This summary shows that almost wherever *Acaena* occurs it is hugely variable. These variants have been given species or subspecific names depending on the author's philosophy.

There is no suggestion in the literature of apomixis or of the peculiar breeding systems of *Rosa* and *Rubus*, the latter providing an infinite number of microspecies. Chromosome

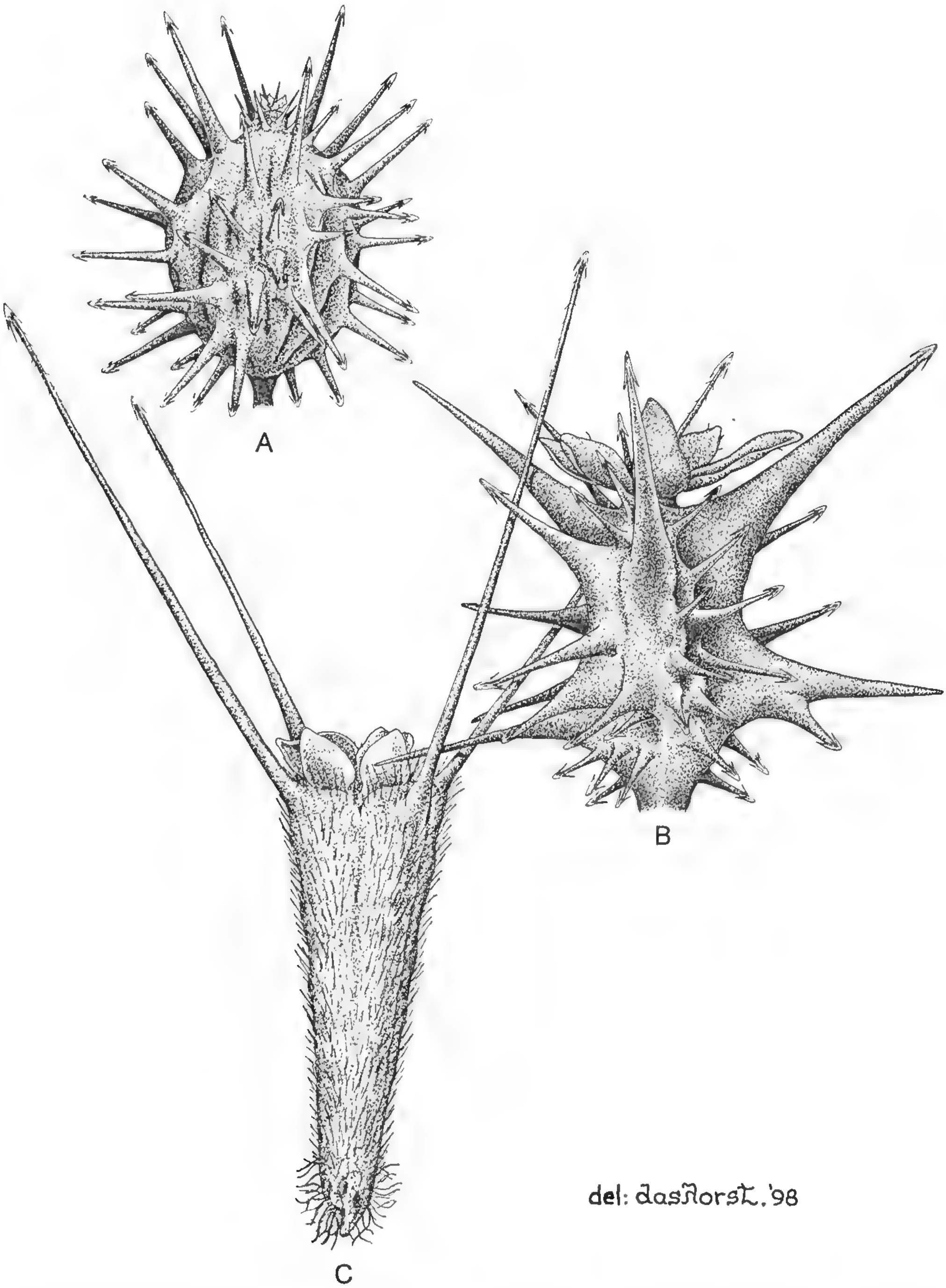

Plate 2. Fruit (×10). **A**, ***Acaena ovina*** (Symon 15223, plant 5); **B**, ***A. echinata*** (Bates 35616, plant 4); **C**, ***A. novae-zelandiae*** (Symon 15307).

counts reported for New Zealand species are 2n = 42, 84 and 126, Beuzenberg (1983), and polyploids are known from South America and the Falkland Islands, Moore & Walton (1970). The numbers for Australian species need checking, especially the occasional very robust populations that are at least suggestive of polyploidy.

In the *A. ovina* complex at least in Australia and the *A. anserinifolia* complex in New Zealand many combinations of individual morphological characters occur. Orchard (1969) uses leaf pubescence, inflorescence branching, fruits glabrous or pilose, spines equal or unequal, spines thickened at the base or slender, stipule length and stamen length in his key.

Orchard (1969) provided a key to the spicate-headed species. His principal leads (somewhat simplified) are shown in Table 1. *Acaena ovina* and *A. agnipila* are characterised by slender spines, and within *A. echinata*, Orchard recognised one variety (*A. echinata* var *subglabricalyx*) with all slender spines, and four varieties with at least some spines with thickened bases.

Population Samples

During the spring and summer of 1994 many population samples of *Acaena* were collected. A single fruiting stem was taken as the unit and specimens were taken simply by walking a transect and collecting a stem from each plant encountered. These have all been pressed, mounted and numbered and are deposited in AD. The plant numbers varied from five to fifty-four, the larger samples were obviously more significant. The distribution of population samples in South Australia is shown in Figure 1.

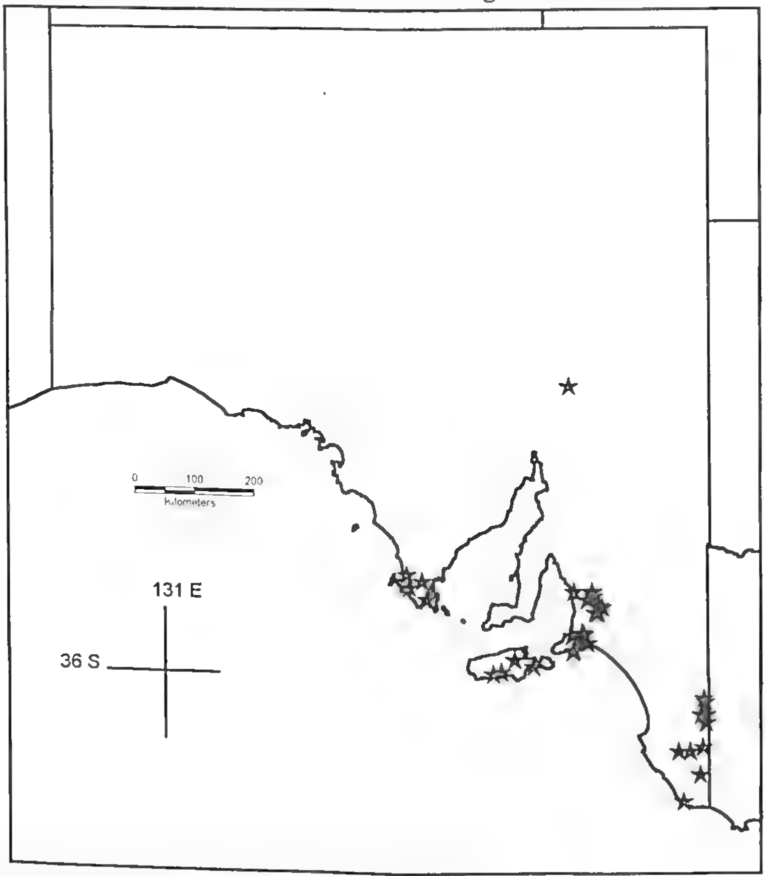

Fig. 1. The distribution of population samples in South Australia.

The collections were then scored for most of the characters previously used in keys to the species in Australia, i.e. pubescence of the leaves, nature of the inflorescence and characters of the fruit. They were not scored for stipules nor stamens, the latter usually absent from fruiting specimens.

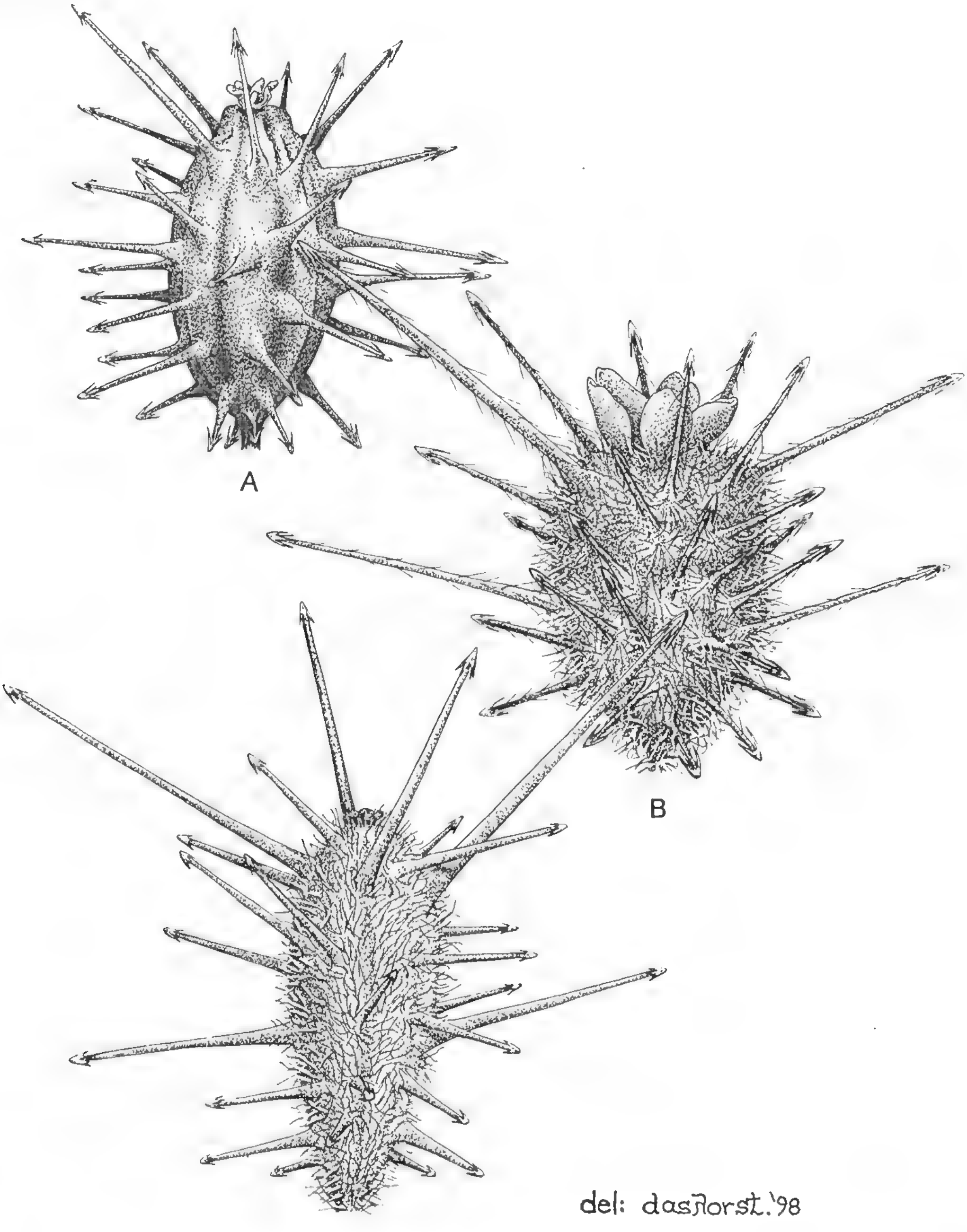

Plate 3. Fruit (×10). A, *Acaena ovina* (*Symon 15308*); B, *A.* ×*anserovina* (*Bates 35503*); C, *A.* ×*anserovina* (*Symon 15311*).

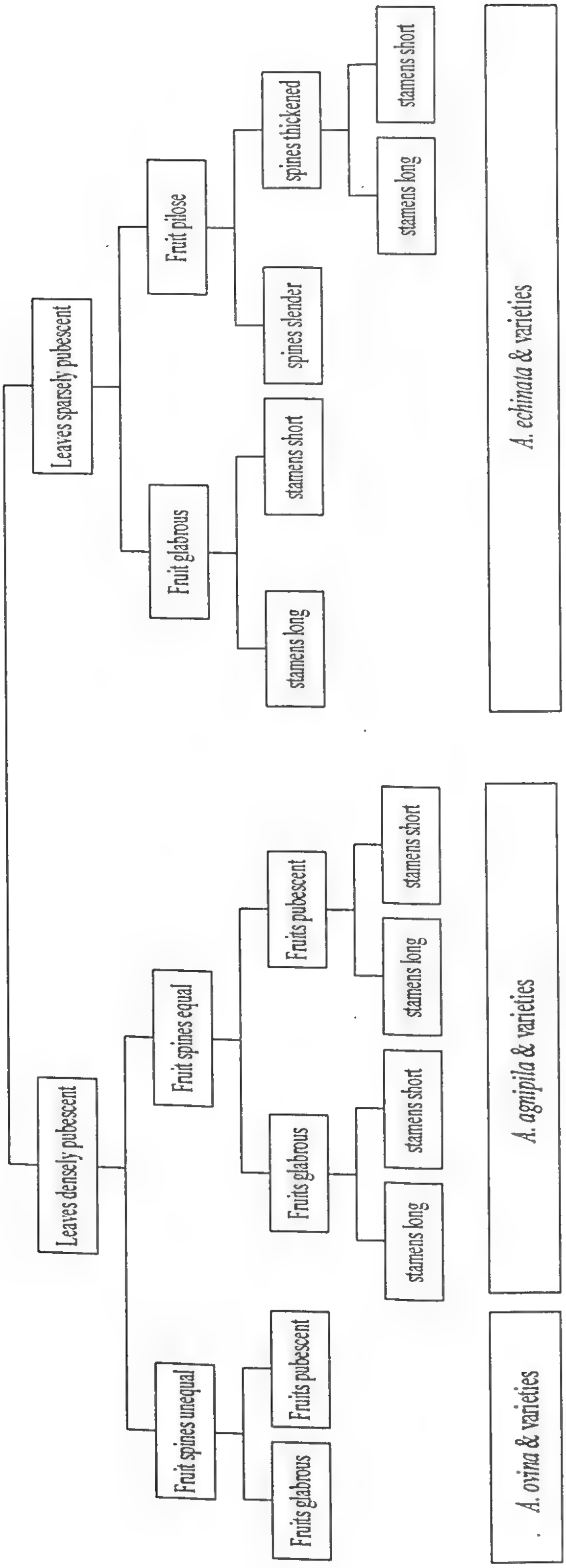

Table 1. Simplified synopsis of key to spicate-headed species from Orchard (1969).

In addition to the ball-headed *A. novae-zelandiae* the three species expected in South Australia are *A. agnipila*, *A. echinata* and *A. ovina*, Orchard (1969).

There is no doubt that where *A. novae-zelandiae* comes in contact with the other species hybrids frequently occur. These were given the name *A. ×anserovina* Orchard and the plants are intermediate between the parents and there is some evidence of hybrid vigour. Orchard (1973) applied this name to the progeny of intercrosses of five species in New Zealand.

Acaena novae-zelandiae is found along our temperate coasts and in the higher rainfall zones. It rarely occurs inland. Apart from the hybrids, it is uniform and in South Australia at least, variants have not been recognised. Although *A. novae-zelandiae* and *A. echinata* have been collected frequently from Kangaroo Island, hybrids have not yet been collected.

The spicate-headed species are more widespread, but nevertheless do not occur in the drier areas of South Australia. Almost all of these form variable populations and only where the samples are small has no significant variation been found. In this paper, two spicate-headed species are recognised in South Australia, *A. echinata* and *A. ovina* (with which *A. agnipila* is considered synonymous).

Kangaroo Island

Three small populations of 7–10 plants were collected, *Symon 15152, 15153, 15154*. These are considered to be *A. echinata*. They were all relatively slender, small-leaved, rosette forming plants with minimal variation.

Eyre Peninsula

Three populations, *Symon 15198, 15203 & 15211*, of 10, 37 and 54 plants have been examined. All are considered to be *A. echinata*. The small population was very uniform except for the occurrence of some very densely flowered late spikes. The second and third populations were more variable and both contained plants with leaves variously pubescent below, a branched inflorescence was present and spicate as well as spike plus ball inflorescences occurred. The fruits were uniformly pubescent in the third population and pubescent or glabrous (10%) in the second. Most of the prickles were markedly unequal and the larger ones flattened at their base. In addition some fruits had relatively short spines. These populations did not include elements of *A. ovina*.

Southern Mt Lofty Range

Many more populations have been sampled in the southern hills area.

Nairne area. Four samples, *Symon 15215, 15216, 15217, 15218* of 9–52 plants were predominantly *A. ovina*. All four recorded variable pubescence. Four single branched inflorescences occurred. Inflorescence form varied from spicate to spike plus ball. The fruits were mostly pubescent but glabrous fruits were also found. Spines varied from equal to unequal; e.g. in Symon 15218, 63% of *A. ovina* plants had more or less equal spines, 34% somewhat unequal and 3% markedly unequal, while 93% of *A. echinata* plants had markedly unequal spines and 7% had somewhat unequal.

Charleston Road. Four samples, *Symon 15220, 15221, 15222, 15223*, of 10–34 plants were collected. The first proved to be a mixed population including *A. novae-zelandiae*, *A. × anserovina* and primarily *A. echinata* with some *A. ovina* present (see Table 2). While the first two were readily recognised, the *A. echinata* consisted of plants variably pubescent, with inflorescences that were spike plus ball, with spines markedly unequal and usually flattened and with fruits pubescent (64%) or glabrous (36%).

An adjacent population but without *A. novae-zelandiae* had variable inflorescence form and 40% of the fruits were glabrous. A population in little disturbed natural scrub was more uniform though it differed in leaf pubescence. The last population varied in leaf pubescence, included a single branched inflorescence, and some glabrous fruits. This population contained a mixture of *A. echinata* and *A. ovina* (Table 2). All *A. echinata* plants had markedly unequal spines. Forty-five percent of *A. ovina* plants had more or less equal spines while 55% had somewhat unequal spines.

Southern Fleurieu Peninsula, Newland Head. Six samples, *Murfet & Taplin 2102, 2103, 2104, 2105, 2106, 2107* of 3–14 plants were collected. These varied from *A. novae-zelandiae,* and its hybrid *A. ×anserovina* when present, with the two potential spicate parents to varied populations of *A. echinata* and *A. ovina.* There were no branched inflorescences except in the hybrid, all fruits were pubescent, one population (*2106*) had more or less equal spines that were acicular rather than flattened.

Hindmarsh Valley and *Hindmarsh Falls.* Six populations, *Bates 39664, 39659, Murfet 2096, 2109, 2111, 2113,* ranged from 4–15 plants each and thus were not large samples. Amongst them branched inflorescences occurred, there was some variation in pubescence and in one (*Murfet 2113*) there was considerable variation in fruit spines.

Mt Crawford, Anstey Hill, Kersbrook and *Cherry Gardens.* Eight samples, *Bates 35506, 35612, 35616, 39684, 40169, 40210, Taplin 643, 697* of 5–50 plants were seen. These collections contained a wide range of material – indeed all the species and hybrids recorded for South Australia. Variation in pubescence was noted, the glabrous fruits had more or less equal acicular spines, no fruits that were glabrous had notably unequal spines, and several branched inflorescences were noted. Only the smallest samples, *Taplin 643* (7 plants) and *Bates 35612* (5 plants) approached uniformity. Other populations were all of mixed characters. In one sample (*Bates 39684*) from Cherry Gardens some influence of *A. novae-zelandiae* seemed apparent though that species was not present in the sample.

Goolwa, Murfet 1908. This sample of 17 plants, nominally *A. echinata* was a robust lot with simple or branched inflorescences, and glabrous or pubescent fruits, but all with unequal spines.

Myponga, Bates 40208. These 8 plants nominally *A. echinata* were uniform.

Mt Compass, Bates 40224. These 11 plants nominally *A. ovina,* were varied and included branched inflorescences, a single pubescent fruit, and varied spines.

South East of South Australia

Ten collections ranging from six to 27 plants were available. *Murfet & Taplin 2300, 2301, 2311, 2319, 2323* and *Symon 15287, 15288, 15289, 15294* were all *A. echinata* though varying in pubescence and some fruit characters. *Symon 15298* included a single *A. ovina* amongst *A. echinata.* However population *Symon 15307 - 15311* (incl) was an example of the occurrence of the hybrid *A. ×anserovina* in the presence of the parents *A. novae-zelandiae* and *A. ovina.*

Northern Mt Lofty Range

Penwortham and *Hilltown,* two samples *Bates 40320, 40322* of 8–10 plants were available. These two samples from north of Adelaide were both nominally *A. echinata* and were both uniform though the second was of a very robust form.

Flinders Ranges

Wilpena, Symon 15349. The occurrence of *Acaena* here is isolated and is a considerable distance from the nearest more southerly populations at Mt. Remarkable. Thirty-eight

samples were collected along about 1km of the creekline leading into the Pound. These were all *A. echinata*. The foliage was relatively uniform, gracile and sparsely pubescent on the main veins below. The fruits were relatively small, more globular and more sparsely spined than many more southern populations. Fruit pubescence was variable, with pubescent, puberulent and glabrous fruits being present.

These samples show that several characters used to base varieties upon commonly occur in one population. The *A. ovina* characteristics are confined to the higher rainfall areas and outlying populations tend to be more uniform and are nominally *A. echinata*.

New South Wales

All the collections referred to so far are from South Australia. Of interest therefore are three from New South Wales, *Lepschi 1715* from between Lake George and Yass, *Lepschi 1720* from near Mt Ainslie, plus *Lally & Lafay 512–513* from the Brindabella Range.

The first, primarily *A. ovina*, of 31 plants had varied leaf pubescence, several branched inflorescences. Of the *A. ovina* plants, 96% had spicate and 4% had spike plus ball inflorescences, 48% had pubescent fruits and 52% had glabrous fruits. *Acaena ovina* plants had equal or unequal spines, and acicular or flattened spines. The second, primarily *A. ovina*, was variable in leaf pubescence. It included some branched inflorescences, and pubescent and glabrous fruits, as well as equal and unequal spines. It is of interest that both are just as varied as several of the larger South Australian collections and again contained *A. echinata* and *A. ovina* (Table 2).

A collection from a higher altitude, 1400 m of the Brindabella Range was in part a hybrid swarm including *A. novae-zelandiae, A.* × *anserovina* and *A. ovina*. *Lally & Lafay 512–513* was of 53 plants and demonstrated minor variation in leaf pubescence, a few weakly branched inflorescence, and no glabrous fruit. The hybrid *A.* × *anserovina* was common and was readily recognised by the inflorescence. The collection included a higher percentage of plants than usual with leaves pubescent on the upper surface.

Western Australia

Two collections were examined, *Lepschi & Lally 3305* from ca. 13.5km NE of Kirup and *Lally & Lepschi 805* from 1.2km N of Mt Barker. Both collections are considered to be *A. echinata*.

Patterns of Morphological Variation

As noted above, several characters upon which varieties have been based vary within populations. For example, glabrous and pubescent fruits co-occur in some populations of *A. echinata*, e.g. *DES 15220*, *15349*. Similarly, glabrous and pubescent fruits co-occur in some populations of *A. ovina*, e.g. *DES 15223*, *Lepschi 1715*. Hence these results throw considerable doubt on the utility of the many varietal names already published.

Leaf pubescence is variable and as the leaves are readily glabrescent care should be taken in assessing that character. In general terms pubescence on the main veins below is associated with pubescent fruits and unequal spines, and leaves densely pubescent below is associated with glabrous fruits though by no means exclusively. Glabrous or pubescent fruits occur with both equal and unequal spines.

Branched inflorescences are scattered through the collections usually at low frequencies and do not appear to be a significant character. In South Australia the inflorescence strictly in a ball is confined to *A. novae-zelandiae*. Spicate and spike plus ball inflorescences are not always easy to categorise but the latter is associated with unequal spines.

The fruit spine character (Plate 1) is very variable. The more or less equal spines tend to be acicular and the larger of the unequal ones tend to be flattened at their base and emphasise the ribbing of the fruit. The spines themselves as distinct from the body of the fruit may be pubescent or glabrous. The body of the fruit may be near-globular to ellipsoid. This character has not been used to date. Anthocyanin pigment varies and is often difficult to assess in old herbarium specimens. In fresh material there are striking differences, the fruits varying from light green to almost purple-black in extreme cases.

Delimitation of Taxa

Varieties based on fruit pubescence or on branched inflorescences scarcely seem tenable (see above). Nor do stipules or stamens appear to be reliable characters at least by observation.

In places *A. echinata* forms more or less uniform populations when assessed by reduced leaf pubescence, spike and ball inflorescence and markedly unequal spines. It also extends to the drier margins of the distribution of the genus.

Those plants with leaves densely pubescent below were previously divided into *A. ovina* and *A. agnipila* on the basis of spine differences Orchard (1969). Those with spines unequal in length but not greatly flattened were called *A. ovina* and those more or less equal and acicular were called *A. agnipila*. The two are not recognised as distinct taxa here because of the extensive overlap of characters (see Figure 4 below), as *A. ovina* is the older name *A. agnipila* becomes a synonym.

Numerical Analysis

Character Coding

Eight characters were scored and included in the analyses. Characters were scored for seven *Acaena* populations from South Australia, one from Western Australia and two from New South Wales (see Tables 2 and 3).

Population	Locality	Taxa			
		A. ovina	*A. echinata*	*A. × anserovina*	*A. novae-zelandiae*
DES 15218	SA E of Nairne (SL)	35	15		
DES 15220	SA Charleston Rd (SL)	6	22	3	3
DES 15223	SA Near Harrogate (SL)	11	15		
DES 15198	SA Eyre Peninsuala, Lincoln N.P. (EP)		10		
DES 15211	SA Kellidie Bay, Eyre Peninsula (EP)		35		
DES 15349	SA Wilpena Creek (FR)		36		
DES 15307-15311 (incl.)	SA "Oaklea" Stn, 4km from Blackfellows Cave on road to Bucks Bay (SE)	11		3	1
Lepschi 1715	NSW 12.5km W of Gundaroo	23	6		
Lepschi 1720	NSW Near Mt Ainslie CP	29	1		
Lepschi & Lally 3305	WA 13.5km NE of Kirup		16		

Table 2. Localities and numbers of plants sampled for numerical analysis

For leaf abaxial surface (character LEAF1), leaves were scored as pilose on main veins (0), or pilose below (1). For leaf adaxial surface (character LEAF2), leaves were scored as not pilose above (0), or pilose above (1). Four fruit characters were scored and included in the analyses. For fruit spine type (SPINE1), two categories were recognised - acicular spines (1), i.e. fruits with all acicular spines, and flattened spines (0), i.e. fruits with at least some spines flattened at their base. Relative size of fruit spines (SPINE2) was categorised into three states - equal (0), i.e. spines equal to subequal in length, somewhat unequal (1), i.e. spines unequal in length but not markedly unequal in thickness, and markedly unequal (2), i.e. spines unequal in length and markedly unequal in thickness. For fruit type (FRUIT1), fruits were scored as ribbed (0), or smooth (1). Three categories of fruit pubescence (FRUIT2) were recognised - glabrous (0), pubescent (1), and puberulent (2). Two inflorescence characters were also scored - INFLOR1, depending on whether inflorescences were ball only (0), spicate and ball (1) or spicate (2); and INFLOR2, depending on whether inflorescences were branched (0) or simple (1).

	TAXON							
	A. ovina		*A. echinata*		*A. × anserovina*		*A. novae-zelandiae*	
	Count	Col %	Count	Col %	Count	Col %	Count	Col %
SPINE1 flattened	51	44.3	150	96.2				
acicular	64	55.7	6	3.8	6	100	4	100
SPINE2 equal	60	52.2	1	.6			4	100
somewhat unequal	52	45.2	7	4.5	6	100		
markedly unequal	3	2.6	148	94.9				
FRUIT1 ribbed	75	65.2	149	95.5	5	83.3	4	100
smooth	40	34.8	7	4.5	1	16.7		
FRUIT2 glabrous	48	41.7	27	17.3				
pubescent	67	58.3	112	71.8	6	100	4	100
puberulent			17	10.9				
INFLOR1 only ball							4	100
spic & ball	46	40.0	141	90.4	6	100		
spicate	69	60.0	15	9.6				
INFLOR2 branched	7	6.1	1	.6	2	33.3		
simple	108	93.9	155	99.4	4	66.7	4	100
LEAF1 pilose main veins	26	22.6	92	59.0				
pilose below	89	77.4	64	41.0	6	100	4	100
LEAF2 not pilose above	51	44.3	137	87.8	6	100	4	100
pilose above	64	55.7	19	12.2				

Table 3. Distribution of character states for plant specimens included in numerical analysis.

Statistical Analysis

Data on the eight morphological traits listed above were subjected to an ordination analysis to further examine relationships among characters and among characters and taxa. Five of the eight morphological characters used in the present analysis were two-state or binary variables and three (SPINE2, FRUIT2 and INFLOR1) had three character states. Accordingly, we used a nonlinear principal components analysis which is appropriate for

data measured on a nominal or ordinal scale. The PRINCALS routine in the SPSS (version 8) software package was utilised for the analysis. To simplify graphical interpretation, a two-dimensional solution was produced from the analysis. This analysis seeks to group together objects (plants) that share the same character states and it indicates the relative

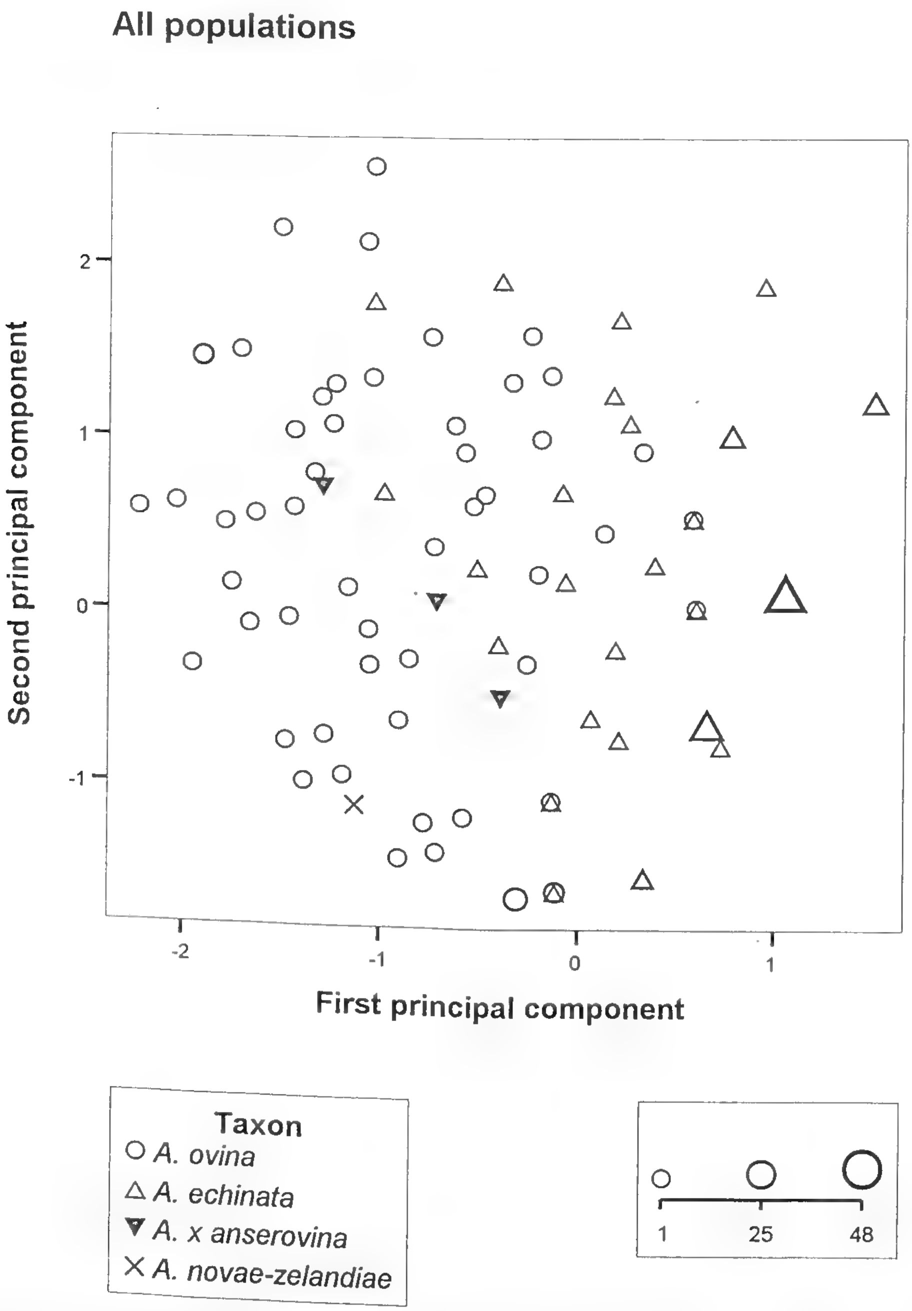

Fig. 2. Plot of the distribution of taxa against the first two principal component axes from the PRINCALS analysis. Symbol sizes are proportional to the number of individuals at that position (see adjacent key).

importance of different categorical variables in contributing to the separation or clustering of different objects. Two analyses were conducted, one on all populations listed above, and one on populations from South Australia.

Results

In the first analysis, the first two principal component axes together accounted for 36% and 20%, respectively, of the overall variation in the data. Inspection of the loadings of the original variables upon these axes showed that variation in the spine characters SPINE1 and SPINE2 was responsible for much of the variation along the first axis, while differences in the pubescence characters, FRUIT2 and LEAF2, accounted for much of the variation along the second axis. Figure 2 shows the distribution of all plants from the sampled populations when plotted against these axes. A weak separation of the taxa was obtained, with a tendency for plants of *A. echinata* to have greater scores than those of *A. ovina* along the first axis. Differences between these two taxa along the second axis were less marked. Plants of *A. novae-zelandiae.* can be distinguished by their having four spines, in contrast to plants of *A. ovina* and *A. echinata* which have more than four, but this trait was not included in the numerical analysis.Hybrid individuals had roughly intermediate values.

When the principal components analysis was repeated on plants from South Australian collections similar results were obtained, with the first two principal component axes accounting for 39% and 21%, respectively, of the overall variation in the data. However, the separation of *A. ovina* and *A. echinata* was considerably more pronounced, with little overlap in the distribution of the taxa (Figure 3). Again, there was less differentiation of these two taxa along the second axis than along the first, confirming the importance of the spine characters in distinguishing them.

In summary, *A. ovina* and *A. echinata* differed in the following characters:- most *A. echinata* plants (95%) had markedly unequal spines; in contrast most *A. ovina* plants had equal spines or somewhat unequal spines and only 3% had markedly unequal spines (Table 3). Orchard distinguished *A. ovina* with unequal spines and *A. agnipila* with equal spines. These are not recognised as two distinct taxa here, *A. agnipila* being considered as synonymous with *A. ovina*. Figure 4 shows that within *A. ovina* as delimited here, there is no clear separation in the principal components analysis between individuals with equal and unequal spines. Flattened spines were more common in *A. echinata* plants (96%) than in plants of *A. ovina* (44%). Glabrous and smooth fruits were more common in *A. ovina* plants than in *A. echinata* plants (Table 3). Spicate plus ball inflorescences predominated in *A. echinata* plants (90%) but were only seen in 40% of *A. ovina* plants. Branched inflorescences were only occasionally observed (Table 3). Regarding leaf pubescence characters, 56% of *A. ovina* plants were pilose above and 77% were pilose below, while only 12% of *A. echinata* plants were pilose above and 41% were pilose below.

Conclusion

In South Australia one uniform species *A. novae-zelandiae,* two variable and weakly differentiated entities *A. echinata* and *A. ovina* and one hybrid *A.* × *anserovina* may be recognised.

A. echinata Nees

Leaves generally pubescent on the main veins below. Inflorescence an irregular spike terminated by a ball of flowers. Spines markedly unequal, the larger ones with flattened bases resulting in a more conspicuously ribbed fruit which may be pubescent or glabrous.

Distribution in all areas of the genus in South Australia.

A. ovina A. Cunn.

Leaves generally densely hirsute-villous below often sparsely pubescent above.

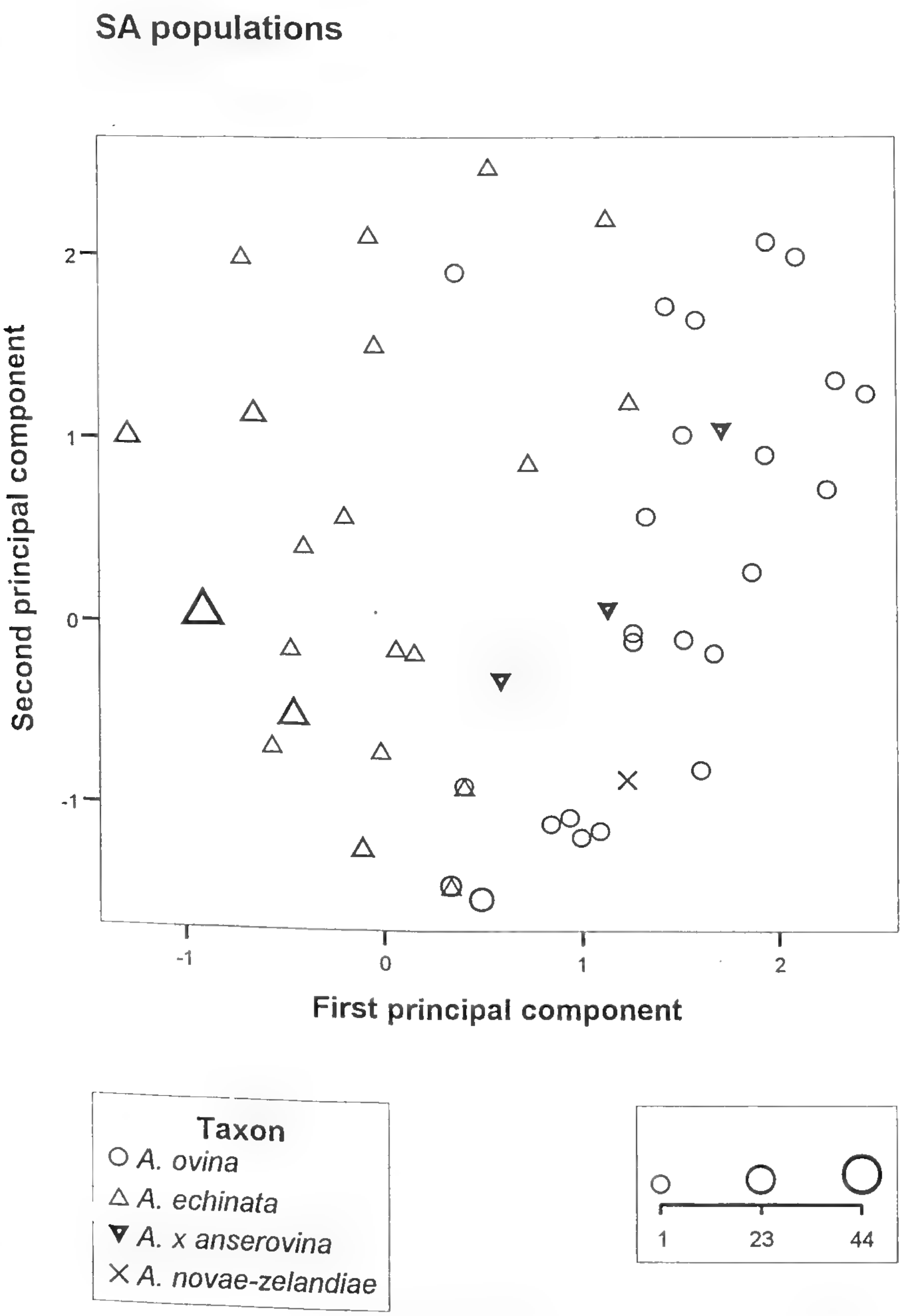

Fig. 3. Plot of the distribution of South Australian taxa against the first two prinipal component axes from the PRINCALS analysis. Symbol sizes are proportional to the number of individuals at that position (see adjacent key).

Inflorescence more uniformly spicate with some apical aggregation but commonly no terminal ball of flowers. Spines equal or unequal (almost always a few larger than the rest) their bases not markedly flattened, fruit less clearly ribbed, glabrous or pubescent.

Distribution in higher rainfall areas of the generic distribution in South Australia.

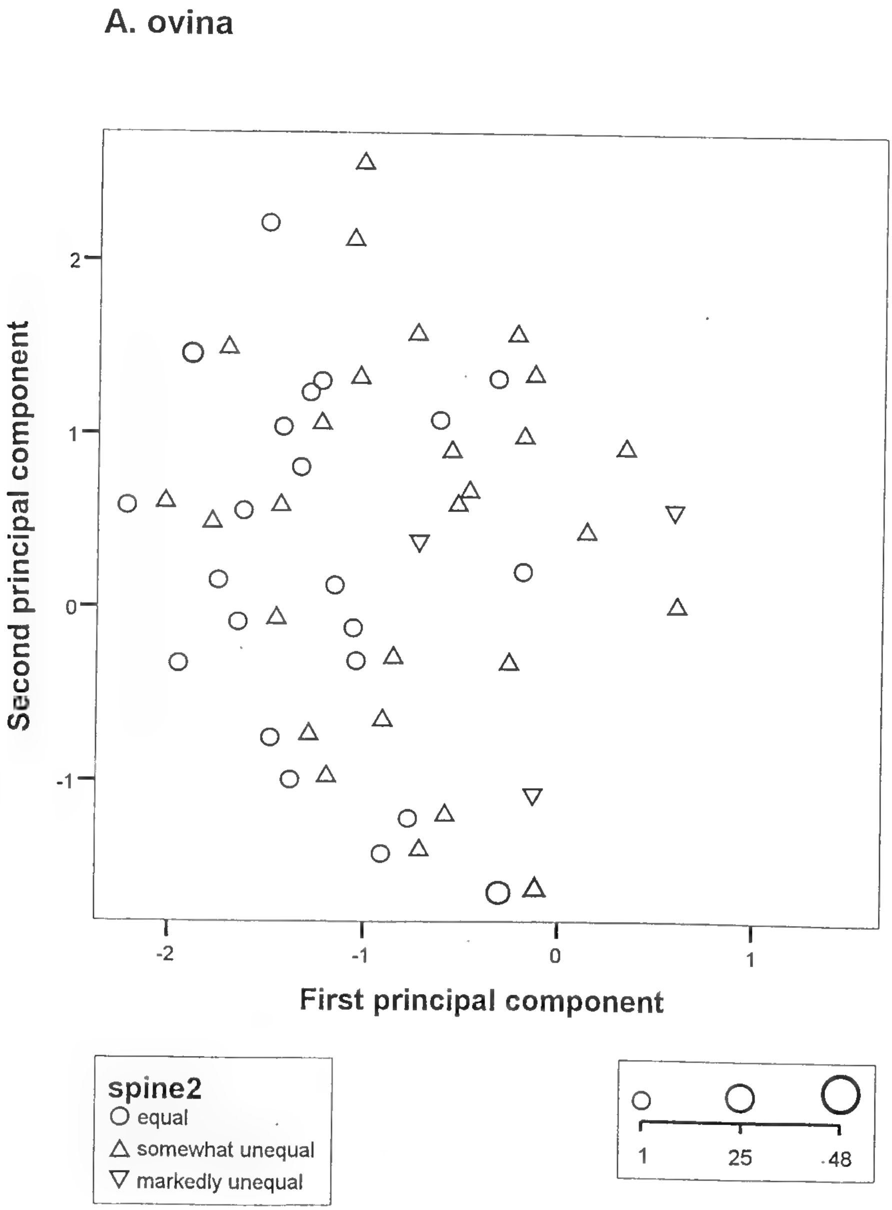

Fig. 4. Plot of the distribution of specimens of *A. ovina* against the first two principal component axes from the PRINCALS analysis, showing the distribution of the SPINE2 character. Symbol sizes are proportional to the number of individuals at that position (see adjacent key).

*A. **novae-zelandiae*** Kirk.

Sprawling, weakly woody shrubs, producing long stolons, the infloresence always in a ball. This taxon is frequently subcoastal in dune swales , less commonly inland.

A. × ***anserovina*** Orchard.

Where *A. novae-zelandiae* occurs in close proximity to *A. echinata* or *A. ovina*, hybrids may be found. They are intermediate in most characters.

The genus *Sanguisorba* may be considered a Northern Hemisphere parallel of *Acaena*. The species have similar incised imparipinnate leaves, lack petals, are wind pollinated, the heads are globose or oblong and the fruits may be smooth or reticulate, commonly have wings and the faces have long or short, stout, papillose outgrowths. The species *S. minor* parallels the problems with *Acaena* here. Nordborg (1967) maintains 6 subspecies which are weakly geographically distinct. Overlaps between all subspecies were common and Nordborg states "The morphological studies in combination with cytologic data could not resolve the taxonomic and evolutionary problems of the section. Nor was it possible with the help of anatomy, palynology and ecology. However all investigations made, pointed to a relatively pronounced continuity." "... all crosses within ssp. *minor* resulted in fertile progeny." Proctor & Nordborg (1968) in *Flora Europaea* add "Differences in the hypanthium are often clearly marked, but they are not always satisfactorily correlated with other characters. So far as is known, there are no sterility barriers between the subspecies which are described."

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DETECTING POLYPLOIDY IN HERBARIUM SPECIMENS OF QUANDONG (*SANTALUM ACUMINATUM* (R.Br.) A.DC.)

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Abstract

Stomate guard cells and pollen grains of 50 herbarium specimens were measured, and the results analysed. There was no evidence of the presence of two size classes of these cell types, and thus no evidence suggesting the presence of two or more ploidy races. High levels of pollen sterility were observed, and the consequences of this sterility in sourcing and managing orchard stock are discussed.

Introduction

In arid areas of Australia, the production of quandong fruit for human consumption is a developing industry. This industry is hampered by several factors in the breeding system of this native tree (*Santalum acuminatum* (R.Br.) A. DC. - Santalaceae). In particular, plants grown from seed collected from trees with desirable fruit characters do not breed true to the parent tree. And grafted trees derived from a parent with desirable fruit characters are not always self-pollinating. This leads to problems in sourcing orchard trees with reliable characteristics, and also problems in designing orchards to provide pollen sources for grafted trees.

It was suggested that natural polyploid individuals (ie. those with multiple sets of chromosomes in every cell) might be more likely to be self-fertile, and show less variability between seedlings from one tree, than diploids (ie. those with the normal two sets of chromosomes). They might also be easier to interbreed. They might thus solve some of the problems faced in domesticating this native fruit.

Polyploidy occurs in other native woody species (e.g *Senna*, Randell, 1970, 1989), and it may also occur in quandong. Ideally, it would be associated with a clear morphological marker (such as leaf width, or flower length) which would give growers an easy method to identify and select polyploid individuals in the field.

Previous studies have shown that the size of some plant cells, which are preserved in herbarium specimens, varies directly with the number of chromosomes contained in the cell nucleus. In particular, pollen grains of polyploid plants of *Senna* are significantly larger than those of their diploid relatives (Randell, 1970). The same relationship holds for the size of stomate guard cells in some other plants (Briggs & Walters, 1984, p. 244).

As both pollen grains and stomates are preserved in dried specimens, the current project surveyed pollen diameters and stomate (guard cell) lengths, in a number of herbarium specimens from many parts of South Australia, to look for indications that more than one ploidy race is present. If analysis showed two distinct peaks in the frequency of the different sizes for pollen grains and/or guard cells, this would be an indication that two different ploidy races were present in the plants sampled .

A number of other characters which might be associated with polyploidy were also measured (eg. leaf width, leaf length, pollen fertility), in the hope that marker characters could be recognised.

Materials: (see listing of herbarium specimens in Table 1):

The fifty plants sampled bore mature flower buds, and well-developed leaves. These were all the plants in the State Herbarium of South Australia, which were collected in South Australia, and had appropriate buds. Some also bore mature fruits or were associated with mature fruits.

Methods

The average stomate diameter of a plant was measured as follows. A 'nail-polish peel impression' was created by painting the lower epidermis of a single leaf with clear nail polish, allowing the polish to dry, covering firmly with clear adhesive tape, then removing both tape and nail polish together. The tape prevented the polish from stretching as it was removed. When the tape was transferred to a glass microscope slide, the polish carried an impression of the stomates against which it dried. The width of the stomates (guard cells) across the pore could then be measured in the nail polish layer. 10--15 stomates were measured before the average was calculated.

The average pollen diameter for a plant was measured as follows. A single mature bud (the largest unopened bud in an inflorescence containing all flowering stages from immature buds to open, spent flowers) was soaked in detergent and water for several minutes, before the anthers (usually four) were dissected out into water faintly coloured with safranin. The anthers were then squashed to release the pollen grains before the debris of the anthers was removed, and the cover slip applied.

In many cases, the pollen released by a single flower was quite variable. The range included grains which were oval, well-formed, with obvious cytoplasmic contents which absorbed safranin, and with 3 median pores, as described by Sedgley (1982). The exine showed no obvious ornamentation, but its structure was not investigated in detail in this study. Grains showing these characteristics were assumed to be 'normal'.

By contrast, the same flower often produced grains which were tiny, and/or without cytoplasmic contents, and/or miss-shaped with the walls collapsing inwards. These grains were assumed to be abnormal.

To calculate the average pollen diameter, 10--15 'normal' pollen grains were measured before the average was calculated (ie. empty, miss-shaped, or very small grains were excluded from the calculations).

Pollen fertility was estimated by eye, surveying the entire surface of the cover slip, and comparing the number of 'normal' pollen grains with the total number of grains present. Three fundamental assumptions underlie these estimates - ie. that pollen grains which appear 'normal' will germinate and function normally; that all flowers on the plant will show the same levels of pollen fertility as a single sampled flower; and that fertility levels displayed in the season the herbarium specimen was collected are typical of those displayed in other seasons, regardless of environmental conditions. None of these assumptions has been tested.

For average leaf widths and leaf lengths, 10--15 measurements of each character were made, before the averages were calculated.

Results

Table 1 includes mean character values for each specimen examined. For each individual character, the recorded range of means was observed, divided into appropriate regular intervals, and the number of records within each interval was scored. (Tables 2 to 6).

No.	Locality	Collector & No.	Date	Leaf width mm	Leaf length mm	Pollen diam. µm	Stomate diam. µm	pollen fert%
1	2 mi inland from clifftops, Koonalda SA (with loose fruits)	DE Symon 4584	17.ii.1967	5.4				
2	Arkaroola Sanctuary	RH Kuchel 2997	19.x.1971	8.7	76.3	16.4	28.1	
3	c. 1 km south Freeling	DN Kraehenbuehl 1562	27.xi.1965	7.5	64		31	
4	John Rd Reserve on S boundary of Salisbury East Regional Park	R Taplin 46	20.i.1988	13.3	56.6	18.3	35.8	
5	2km SE of Anna Ck HS; 16km W of William Creek	FJ Badman 1161	3.vi.1984	10.1	78	18.8	33.5	
6	Coffin Bay Peninsula, near W end of Pt Longnose	LD Williams 11776	21.i.1981	9.1	61	19	42.25	
7	10 km SW of Pt Clinton	LD Williams 7560	21.i.1976	9.6	85.8	19.5	41	50
8	ca. 11km E of Eudunda	HM Cooper s.n.	Oct. 1941	7.4	66	20.5	46.5	20
9	c. 10km W of Murray Bridge, 5km W of Railway crossing	JZ Weber 3683	22.i.1974	4.6	60.8	19.75	34.3	90
10	Reserve 4 miles E of Two Wells	JB Cleland s.n.	3.iii.1960	9.1	83	18.5	32.3	90
11	Across from Goolwa effluent ponds	DE Murfet s.n.	1987	8.3	71	19.75	34.8	
12	1 mile west from Mannum	MCR Sharrad 957	1.ii.1961	3.5	33	18.3	29.5	90
13	scrub to north east of Barossa reservoir (with loose fruits)	AG Spooner 6302	4.ii.1979	6.1	51.6	19	26.9	85
14	Normanville - top of north dune	AG Spooner 10628	4.iv.1987	7.8	73.3	18.5	40.5	50
15	Grange Golf course	TJ Smith 1139	15.i.1968	5.2	57.5	20.8	35.5	70
16	19km E Oparinna Spring, W end of Musgrave Range	HH Finlayson	Dec. 1932	10.4	100.8	17	30.5	40
17	Sellicks Beach scrub	JB Cleland s.n.	26.i.1963	8.7	64.2	18.1	29.5	90
18	Roadside dune vegetation, Point Souttar	AG Spooner 6317	2.iii.1979	8.2	60.7	19.5	36	50
19	Bower Road, Semaphore	DN Kraehenbuehl 560	7.iii.1962	10.3	51	18.25	35.8	85
20	10km E of Secret Rocks, Cowell-Kimba Road	DN Kraehenbuehl 4096	5.ii.1984	4.5	57.5	21.3	31.8	90
21	Monarto roadside west from Monarto South	CR Alcock 5508	11.i.1977	8.5	77	22.3	39.4	90
22	c. 6km W of Malinong hall, c. 45km SE of Murray Bridge	MCR Sharrad 1295	30.i.1962	5.6	42.5	20.4	39.8	90
23	South Hummocks (34°S; 138°E)	JS Womersley 37	24.ii.1963	4.8	44.2	17.8	32	97
24	Hundred of Wiltunga, upper Yorke Peninsula	B Copley 1051	5.i.1967	8.8	71	19	33.5	90
25	Price Cemetary, c. 30km north of Maitland	SP Culic for LD Williams 7980	na	5.9	48	22.8	34.8	85

No.	Locality	Collector & No.	Date	Leaf width mm	Leaf length mm	Pollen diam. µm	Stomate diam. µm	pollen fert%
26	West Terrace Cemetary, Adelaide City	DN Kraehenbuehl 4826	13.ii.1987	4.9	55	18.5	31.25	90
27	2–3 km north-east of Tanunda township	DN Kraehenbuehl 2980	20.i.1967	9	63	23.5	38.25	25
28	C. 16km E of Kimba on Main Road	R Hill 1515	17.i.1965	6.1	65	20.25	38.5	20
29	Koonamore, c. 60km north of Yunta	TGB Osborn	Dec. 1924	7.9	78	20.25	37.8	85
30	Normanville sand dunes, north of Jetty	PJ Lang 246	30.xii.1974	6.5	60	20.5	34	15
31	Torrens Road, East Highbury, Adelaide	AG Spooner 729	25.iii.1970	7.6	63	21.8	37.5	50
32	Semaphore South	TJ Smith 1125	8.ii.1968	7.4	47	21.3	31.8	85
33	Corner of Robert Road and Taylors Road, Angle Vale	DN Kraehenbuehl 4718	1.iii.1986	6.9	60	17.8	33.3	25
34	Beside road SW of Iron Knob to Kimba	DD Cunningham 1226	4.i.1996	7	70	19.3	31.8	95
35	Melrose, c. 60 km SE of Port Augusta	EH Ising s.n.	28.xii.1938	5.5	80	20.3	32.3	30
36	Melrose Plain, c. 60km south east Pt Augusta	H Amtsberg s.n.	20.i.1972	4.5	60	18.5	24.5	95
37	Porter Bay, S of Pt Lincoln	DE Symon 13607	19.xii.1983	8.5	77	20	34.5	20
38	2.5 mi north of Cowell on the Whyalla road	R Pearce s.n.	Feb. 1965	5.6	46	22.3	38.3	10
39	Porter Bay, south of Port Lincoln	FD Morgan s.n.	19.xii.1983	6.1	54	17.5	28.3	90
40	Australian Arid Lands Botanic Garden, Pt Augusta	JR Zwar 56	22.xii.1992	8.7	81.6	19.3	42	85
41	Sand dunes near Redcliff Point (with attached fruit)	RJ Chinnock 1531	31.viii.1974	5.2	63.3	17.8	32.8	30
42	Buckleboo, County Buxton	RD Rohrlach 37	17.i.1959	6.5	98	19.8	35.3	95
43	Road to Midgee Rocks from Cowell, Eyre Peninsula	R Pearce s.n.	23.i.1965	5.8	53	19.5	31.8	50
44	C. 35km along Kingoonya Rd from Pt Augusta	TRN Lothian s.n.	4.i.1956	5.5	68	21.3	31.3	75
45	Bimbowrie, c. 80km W of Cockburn (with loose fruit)	W Pearce jnr	1892-95	7.6	88	17.3	30.8	70
46	Koonamore Vegetation reserve, Yunta	B Lay 2	30.i.1970	6.2	69.1	19.8	36.8	70
47	Canopus Homestead, c. 75km north of Renmark	KJ Mack s.n.	9.i.1969	7.6	90.8	22.8	33	55
48	Ucontitchie Hill (33°S, 135°E) Eyre Peninsula	PE Hornsby s.n.	March 1993	6.6	75	18	29.5	90
49	9 km NNE of Yarna Homestead (32°S, 135°E)	LD Williams 9134	15.ii.1977	7.5	79.2	19.5	29.5	40
50	Midgee Rocks area, on road to Mitchelville, NE Cowell	R Pearce s.n.	Feb. 1965	5.4	61.7	19.5	35	70
	Means of values			**6.74**	**61.99**	**18.43**	**32.13**	**62.6**
	Standard deviation			**2.47**	**20.68**	**4.86**	**8.94**	**30.22**

Table 1. Herbarium specimens sampled.

Average stomate width (µm)	No. of records
20–22.49	0
22.5–24.9	1
25–27.49	3
27.5–29.9	8
30–32.49	12
32.5–34.9	11
35–37.49	7
37.5–39.9	7
40–42.49	4
42.5–44.9	0
45–47.5	1

Table 2. Average stomate width

Average pollen diameter (µm)	No. of records
16–16.9	1
17–17.9	6
18–18.9	10
19–19.9	14
20–20.9	8
21–21.9	4
22–22.9	4
23–23.9	1

Table 3. Average pollen diameter

Average leaf length	No. of records
30–39	1
40–49	1
50–59	3
60–69	8
70–79	12
80–89	11
90–99	7
100–110	7

Table 4: Average leaf length

Average leaf width (mm)	No. of records
3–3.9	1
4–4.9	5
5–5.9	10
6–6.9	8
7–7.9	10
8–8.9	8
9–9.9	4
10–10.9	3
11–11.9	0
12–12.9	0
13–13.9	1

Table 5. Average leaf width

Discussion

Tables 2 to 5 display the frequency of records within each interval of mean values of most characters examined (pollen diameter, stomate width, leaf length, and leaf width). Each table shows only a single peak frequency i.e. there is no evidence for the presence of two cell sizes, or two leaf sizes, or two ploidy races within the plants sampled.

Table 6 indicates that many plants show significant levels of male (pollen) sterility; i.e. that although male gametes are produced, many of them will not function normally. Some plants which show high male-sterility can set fruit (e.g. *Chinnock 1531*, 30% fertile with attached immature fruit). Previous work on one plant (Sedgley, 1982) has shown 50% female-sterility in a sample of 48 flowers (i.e. flowers that appear normal, but do not contain female gametes).

Estimated pollen fertility	No. of records
0–9	0
10–19	1
20–29	5
30–39	2
40–49	2
50–59	6
60–69	0
70–79	5
80–89	6
90+	15

Table 6. Estimated pollen fertility

Groups of plants which never set fruit (eg. in coastal reserves south of Adelaide, at Hallett Cove Conservation Park, and Aldinga Scrub) may be either female-sterile and/or male-sterile, and/or self-incompatible. Conversely, isolated plants which set good fruit (reported by, for example, D. Matthews *pers. com.*) must be highly fertile ie. male-fertile, female-fertile and self-compatible (see also Sedgley 1982).

Plants that show high male-sterility sometimes occur in close proximity with plants that show high male-fertility eg *F.D.Morgan s.n. (19.12.1983) and D.E.Symon 13607 (19.12.1983)* Porter Bay near Pt Lincoln, 90% and 20% fertile; *R. Pearce s.n. (23.1.1965), and R. Pearce s.n. (Feb.1965)* Midgee Rocks area, 50% and 70% fertile; *E.H. Ising s.n. (1938) and H. Amtsberg s.n. (1972)* Melrose, 30% and 95% fertile; *P.J. Lang 246 (1974) and A.G.Spooner 10628 (1987)* Normanville sand dunes 15% and 50% fertile (all cited in Table 1).

Consequences of pollen sterility

For orchard purposes, it is important to select trees for male-fertility as well as fruit characters. The only reliable pollen sources currently available are isolated trees which are known to fruit well. These could be used as the source of pollen-producing grafts, perhaps as single branches in trees selected for fruit characteristics. It is apparent that insects are required to transfer pollen even in flowers of trees that are both male-fertile and female-fertile (Sedgley, 1982).

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NEW TAXA OF *EUCALYPTUS* INFORMAL SUBGENUS *SYMPHYOMYRTUS* (MYRTACEAE), ENDEMIC TO SOUTH AUSTRALIA

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Abstract

From *E.* ser. *Rufispermae* Maiden, a new subspecies is recognised and described as *E. phenax* Brooker & Slee subsp. ***compressa*** Nicolle distributed on Kangaroo Island and the adjacent mainland. From *E.* ser. *Viminales* Blakely, a new subspecies is recognised and described as *E. goniocalyx* F. Muell. ex Miq. subsp. ***exposa*** Nicolle distributed in the Elder and Wilpena Pound Ranges. From *E.* informal sect. *Adnataria* Pryor & Johnson, *E. lansdowneana* F. Muell. & J. Brown subsp. *albopurpurea* Boomsma is raised to specific rank as ***E. albopurpurea*** (Boomsma) Nicolle and *E. albopurpurea* and *E. lansdowneana* are described under revised circumscription. A new series, *E.* ser. ***Vagitae*** Nicolle, is described to accommodate *E. lansdowneana*. Keys are provided for South Australian taxa of *E.* ser. *Rufispermae* and *E.* ser. *Viminales* and maps are provided for *E. phenax* subsp. *compressa* and *E. nortonii* subsp. *exposa*.

Introduction

The two new subspecies and a new combination described here are not related within *Eucalyptus* other than belonging in the large and diverse *E.* informal subgenus *Symphyomyrtus* Pryor & Johnson (1971). All belong in different sections but share relatively restricted distributions within South Australia and have long required formal recognition.

The Kangaroo Island *E.* ser. *Rufispermae* taxon here described as *E. phenax* subsp. *compressa* has in the past been included in *E. conglobata* (Brooker & Kleinig, 1990), *E. phenax* (erroneously referred to as *E. anceps* R.Br. ex Maiden) (Boomsma et al., 1980; Jessop, 1993) or both (Chippendale, 1988). Neither *E. conglobata* nor *E. phenax* sens. strict. (subsp. *phenax*) is here recognised as occurring on Kangaroo Island.

The northern Flinders Ranges variant of *E. goniocalyx* has been poorly collected until relatively recently but has for some time been seen as a potentially new taxon by a few who have collected it (Brooker, pers. comm; Lang, pers. comm.). More extensive collections and survey have shown it to be a distinctive but variable taxon and it is here described as *E. goniocalyx* subsp. *exposa*.

E. lansdowneana subsp. *albopurpurea* has long been generally regarded as relatively unrelated to subsp. *lansdowneana* and worthy of specific status. Despite this, the two taxa have been continuously treated as a single species. *E. lansdowneana* subsp. *albopurpurea* is here raised to specific rank as *E. albopurpurea*. A new series (*E.* ser. *Vagitae*) is described to accommodate the unique and taxonomically isolated *E. lansdowneana*.

Taxonomic treatment

Eucalyptus ser. **Rufispermae** Maiden, *Critical Revision Genus Eucalyptus* 7: 152 (1929).

Type: *E. woodwardii* Maiden.

A large series distributed from western Victoria and central New South Wales westwards to the western seaboard in Western Australia. The series is distinguished by its combination

of mallee or small tree habit; reniform cotyledons; presence of pith glands; juvenile leaves petiolate and alternating; adult leaves alternate, petiolate and concolorous; stamens inflexed and all fertile, and the glossy, red-brown seeds.

Key to South Australian taxa of *E.* ser. *Rufispermae*

Only a key to South Australian taxa of series Rufispermae is presented as many undescribed taxa of Rufispermae are known, mostly in Western Australia (Brooker & Hopper 1993).

1. Branchlets glaucous
    2. Bark completely smooth .... **E. cretata**
    2. Bark persistent and fibrous on lower half of stems
        3. Fruit < 9 mm diam., adult leaves predominantly lanceolate .... **E. gypsophila**
        3. Fruit > 9 mm diam., adult leaves broad-lanceolate to ovate .... **E. canescens** subsp. **canescens**
1. Branchlets not glaucous
    4. Bark persistent on lower half of stems, fibrous
        5. Fruit < 9 mm diam .... **E. gypsophila**
        5. Fruit > 9 mm diam .... **E. canescens subsp. beadellii**
    4. Bark smooth throughout, or ribbony-rough on lower stems (not fibrous)
        6. Mature adult leaves glossy, dark green to olive green
            7. Pedicels < 3 mm long
                8. Fruit wider than long, 7 to 12 mm wide .... **E. conglobata**
                8. Fruit equal to or longer than wide, 5 to 9 mm wide
                    9. Peduncles 3 to 7 mm long, fruit longer than wide .... **E. phenax** subsp. **phenax**
                    9. Peduncles 6 to 16 mm long, fruit equal in length and width ..... **E. phenax** subsp. **compressa**
            7. Pedicels > 3 mm long
                10. Operculum wider than hypanthium at join, pileate, adult leaves glossy, dark green.... **E. pileata**
                10. Operculum more or less flush with hypanthium at join, pileate to conical, adult new growth dull .... **E. calcareana**
        6. Mature adult leaves dull to slightly glossy, blue-green to grey
            12. Adult leaves dull, grey, 25 to 40 mm wide .... **E. cyanophylla**
            12. Adult leaves dull to slightly glossy, blue-green, 15 to 25 mm wide
                13. Operculum wider than hypanthium at join, ribs on operculum > 0.8 mm high...... **E. percostata**
                13. Operculum more or less flush with hypanthium at join, ribs on operculum < 0.5 mm high .... **E. dumosa**

1. **Eucalyptus phenax** Brooker & Slee subsp. **compressa** Nicolle, *subsp. nov.*

Eucalyptus phenax subsp. 'Kangaroo Island' of Nicolle, *Eucalypts S.Austr.* 1997, 96.

A subspecie typica foliis adultis crassioribus latioribus, peduncullis longioribus et lata, alabastris majoribus, pedicellis brevioribus et fructibus majoribus differt.

Distinguished from *E. phenax* subsp. *phenax* by the broader, thicker adult leaves; longer, thicker peduncles; buds lacking pedicels and fruit about equal in length to width.

Distinguished from *E. conglobata* by the prominent, long peduncles and smaller adult leaves, buds and fruits and fruit that are about equal in length and width.

Typus: South Australia: Kangaroo Island Region: Playford Highway, 1.1 km south-west of junction of road to Emu Bay, Kangaroo Island, 9.iii.1977, *P. J. Lang 733* (holo: AD; iso AD)

Mallee, often robust and erect in habit, 3 to 9 metres tall. *Bark* rough, ribbony, tan to grey bark at the base or to about 2 metres, then smooth light grey to grey over grey to tan bark above, decorticating in ribbons. Forming *lignotubers*. Pith glands present. *Cotyledons* reniform. Seedling leaves opposite for about three pairs then alternating, petiolate, (ovate to) broad-lanceolate, to 45 mm long × 20 mm wide, discolorous, glossy, green. *Adult leaves*

alternating, petiolate, lanceolate to broad-lanceolate, 60–140 mm long × 14–30 mm wide, concolorous, glossy, slightly blue-green at first, soon becoming green to dark green; reticulation dense but broken, oil glands abundant, at intersections of veinlets, lateral veins at 35° to 55° from midrib. *Inflorescences* axillary, unbranched, 7-flowered; peduncles thick, flattened and widening towards summit, 8–16 mm long; pedicles absent or to 1 mm long. *Buds* ovoid to clavate, 9–11 mm long × 4–6 mm diam., operculum conical to slightly beaked, apiculate or rounded, striated to ribbed, scar present. *Stamens* strongly inflexed, all fertile; anthers versatile, oblong, opening by longitudinal slits. *Flowers* white. *Ovules* in 4 vertical rows. *Fruits* sessile and very crowded, cupular to hemispherical, 6–8 mm long × 6–9 mm diam., smooth or angular, especially towards base of hypanthium; disc descending; valves 3-5, at about rim level. *Seed* compressed-ovoid, glossy, bright red to red-brown, finely reticulate; chaff red-brown.

Etymology. From the Latin *compressus* - pressed together, referring to the crowded fruit umbellasters compared to the type subspecies.

Selected specimens (West to east)

SOUTH AUSTRALIA: Kangaroo Island Region: Playford HW, between Ropers Rd and Birchmore Rd, Kangaroo Island, 35°43'38"S, 137°28'04"E, 25.ix.1994, *D. Nicolle 1054* (AD, CANB); Cnr of Playford HW and Arranmore Rd, Kangaroo Island, 35°42'32"S, 137°30'45"E, 30.iv.1994, *D. Nicolle 824* (AD); North Coast Rd, between Gap Rd and Grid Iron Cnr, Kangaroo Island, 35°37'34"S, 137°31'35"E, 30.iv.1994, *D. Nicolle 821* (AD); Three-chain Rd, between Marapana Rd and Hundred Line Rd, Kangaroo Island, 35°53'54"S, 137°33'05"E, 24.ix.1994, *D. Nicolle 1045* (AD); Bay of Shoals, on roadside 4.0 km north east of bitumen road to Wisanger, ca 100 m from coast, Kangaroo Island, 5.iii.1977, *P.J. Lang 680* (AD); Playford Highway, 1.1 km south west of junction of road to Emu Bay, Kangaroo Island, 9.iii.1977, *P.J. Lang 732, 734, 735, 736* (AD); Near Kingscote, Kangaroo Island, 35°35'S, 137°40'E, 10.iv.1948, *C. Boomsma s.n.* (AD); 16 km south west of American River on road linking American River with Boundary Road. (At Junction with road heading north west past "Salt Lagoon"), Kangaroo Island, 6.iii.1977, *P.J. Lang 686, 688* (AD); North west of American River on road to Red Banks, 0.8 km north west of road linking Point Morrison to Birchmoor Highway, Kangaroo Island, 5.iii.1977, *P.J. Lang 666, 667, 668, 669, 670* (AD). 1.6 km north west of Chapman River on road from Penneshaw to Cape Willoughby, Kangaroo Island, 4.iii.1977, *P.J. Lang 652, 653, 656* (AD); Dudley Peninsula, Kangaroo Island, 35°46'53"S, 138°03'23"E, 25.ix.1994, *D. Nicolle 1058* (AD, CANB); 0.5 km along Wilson River Road from junction with Cape Willoughby Road, Kangaroo Island, 4.iii.1977, *P.J. Lang 659, 660, 661* (AD). Southern Lofty Region: Mount Scrub Rd, Fleurieu Peninsula, SA, 35°35'55"S, 138°26'27"E, 28.v.1995, *D. Nicolle 1358* (AD, CANB, PERTH); Near "Balbara Stud", 0.5 km east north east [of] ford on Coolawang Creek on road from Mt. Scrub to Mt. Desert, 35°36'S, 138°26'E, 19.iii.1977, *P.J. Lang 750, 751, 753* (AD); East of Callowonga Hill, west of Victor Harbor, SA, 25.vii.1992, *D. Nicolle 77* (CANB); Mount Scrub Rd, Fleurieu Peninsula, SA, 35°36' 07"S, 138°24'57"E, 28.v.1995, *D. Nicolle 1359* (AD).

Distribution and habitat

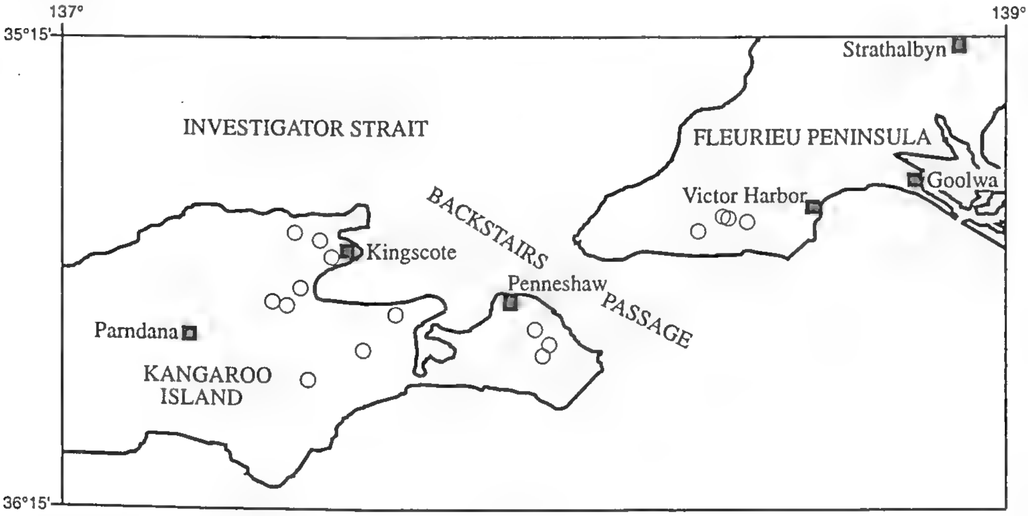
Common on northern and eastern Kangaroo Island, extending to southern Fleurieu Peninsula in hilly sites around Waitpinga. It occurs in mallee vegetation on Kangaroo Island with *E. cneorifolia*, *E. diversifolia* (subsp. *diversifolia*) and *E. fasciculosa*, mostly in loams, or with *E. odorata*, *E. fasciculosa*, *E. cneorifolia*, *E. obliqua*, *E. cosmophylla* and *E. leptophylla* on the adjacent mainland in gravelly clays to loams. Map 1.

Flowering period: Spasmodic, but usually from September to January.

Notes

This taxon is distinguishable from *E. phenax* subsp. *phenax* and *E. conglobata* in the thick, flattened, long peduncles. It is somewhat intermediate in bud and fruit morphology between the two species. With the circumcription of *E. phenax* subsp. *compressa*, the most easterly known locality for *E. conglobata* is in Lincoln National Park, close to the type locality, and the adjacent Taylor Island. *E. phenax* subsp. *compressa* is the only taxon in *E.* ser. *Rufispermae* known from Kangaroo Island. Integradation between *E. phenax* subspp. *phenax* and *compressa* occurs commonly where their distributions overlap in an area from

around Goolwa to north-east of Finniss. Hybrids are known with *E. rugosa* on Kangaroo Island, the only other species known on the island of the informal *E.* sect. *Dumaria* (Pryor & Johnson, 1971). Hybrids between *E. phenax* subspp. *phenax* - *compressa* intergrades and *E. odorata* are known north of Goolwa (e.g. *D. Nicolle 1360*).



Map 1. Distribution of ***Eucalyptus phenax*** subsp. ***compressa*** (O).

Conservation status

Poorly conserved both on Kangaroo Island and Fleurieu Peninsula, mostly occurring as remnants along roadsides. Not known to occur in any conservation reserves. The conservation code 2R is recommended using the criteria of Briggs & Leigh (1996).

Taxon	*E. conglobata*	*E. phenax* subsp. *compressa*	*E. phenax* subsp. *phenax*
Distribution	Lower EP and adjacent islands in S.Aust. and south coast of W.Aust.	North-eastern Kangaroo I. and adjacent mainland. S.Australian endemic.	Widespread in W.Aust., S.Aust. and into Vic., more inland than other two taxa.
Habit	Mallee or rarely slender tree.	Mallee, often erect in habit.	Mallee.
Bark	Smooth, ribbony towards base.	Smooth, ribbony towards base.	Smooth, sometimes ribbony towards base.
Adult leaves	Lanceolate to broad-lanceolate.	Lanceolate to broad-lanceolate (up to 30 mm wide).	Lanceolate.
Peduncles	Absent to 6 mm long.	6–16 mm long.	3–7 mm long.
Pedicels	Absent.	Absent to 1 mm long.	Absent to 3 mm long.
Bud size	6–12 mm long by 5–9 mm wide.	6–11 mm long by 4–6 mm wide.	5–8 mm long by 3–6 mm wide.
Fruit size	4–7 mm long by 7–12 mm wide. Wider than long, average ratio 1:1.8.	6–8 mm long by 6–9 mm wide. Width and length about equal, average ratio 1:1.	6–8 mm long by 5–8 mm wide. Longer than wide, average ratio 1:0.8.

Table 1. Differentiating characters between ***E. conglobata*** and ***E. phenax*** subspp. ***phenax*** and ***compressa***

Eucalyptus ser. **Viminales** Blakely, *Key Eucalypts* 37, 160 (1934).

Type: *E. viminalis* Labill.

A large series restricted to the eastern States as far north as near Brisbane in Queensland and extending westwards as far as Port Lincoln on Eyre Peninsula in South Australia (*E. viminalis* subsp. *cygnetensis*). The series is distinguished by the combination of bilobed cotyledons; sessile and opposite juvenile leaves; lack of pith glands; one to seven-flowered inflorescences and inflexed or irregularly flexed stamens.

Key to South Australian taxa of *E.* ser. *Viminales*

1. Inflorescences predominantly three-flowered
 2. Fruit glaucous, > 12 mm diameter .... **E. bicostata**
 2. Fruit not glaucous, < 12 mm diameter
  3. Bark rough on trunk and large branches .... **E. viminalis** subsp. **cygnetensis**
  3. Bark smooth, some rough bark may be present for up to 2 metres only
   4. Juvenile leaves lanceolate, green .... **E. viminalis** subsp. **viminalis**
   4. Juvenile leaves orbicular, bluish .... **E. dalrympleana** subsp. **dalrympleana**
1. Inflorescences predominantly seven-flowered
 5. Buds and fruits pedicellate .... **E. viminalis** subsp. **cygnetensis**
 5. Buds and fruits sessile
  6. Bud hypanthium not angular .... **E. splendens** subsp. **arcana**
  6. Bud hypanthium angular towards base
   7. Adult leaves glossy, dark green; branchlets never pruinose .... **E. goniocalyx** subsp **goniocalyx**
   7. Adult leaves dull, green to bluish; branchlets often slightly pruinose .... **E. goniocalyx** subsp. **exposa**

2. Eucalyptus goniocalyx F. Muell. ex Miq. subsp. exposa Nicolle, *subsp. nov.*

A subspecie typica statura parviore "mallee", cortice deciduo vel aliquantum persistenti, foliis juvenilibus minoribus et internodis brevioribus, foliis adultis minoribus hebetibusque, ramulis alabastris fructibusque glaucescentibus differt.

Distinguished from subsp. *goniocalyx* in the mallee habit, less extensive or absence of rough bark, smaller juvenile leaves with shorter internodes, smaller and duller adult leaves and the variably pruinose branchlets, buds and fruits.

Typus: South Australia: Flinders Ranges Region: Tanderra Saddle, Wilpena Pound Range, SA, 21.vi.1997, *D. Nicolle 1997* (holo: AD; iso: CANB, NSW, PERTH).

Mallee 3 to 6 m tall. *Bark* variable, depending on the size of the plant, completely smooth on smaller mallees, ribbony, dark grey to grey over cream to white, becoming glaucous towards branchlets; larger mallees with some rough, thin, dark grey to grey box-type bark for 1–2 metres then smooth above. Forming lignotubers. *Branchlets* very weakly to strongly glaucous; pith glands absent. *Cotyledons* bilobed. *Seedling* leaves opposite, sessile for numerous pairs, orbicular, 14–30 mm long × 14–34 mm wide, discolorous, dull, glaucous, grey-green to grey, seedling stems slightly square in transverse section, slightly warty, nodes 15-25 mm apart. *Adult leaves* alternating, petiolate, lanceolate to falcate, 75–160 mm long × 14–21 mm wide, concolorous, dull to slightly glossy, (light green to) bluish; reticulation moderate, with scattered island and intersectional oil glands, lateral veins at 45° to 60° from midrib. *Inflorescences* axillary, unbranched, 7-flowered; peduncles slightly to prominently flattened, 5–8 mm long; pedicels absent. *Buds* ovoid, 7–11 mm long × 2.5–3.5 mm diam., often glaucous, hypanthium often slightly angular, operculum equal to or slightly wider than hypanthium, conical, apiculate. *Stamens* variously flexed, all fertile; anthers versatile, oblong, opening by longitudinal slits. *Flowers* white. *Ovules* in 4 vertical rows. *Fruits* sessile, cupular to slightly campanulate, smooth, often glaucous, 6–8 mm long × 6–8 mm diam.; operculum scar very narrow, ascending; disc slightly descending to

slightly ascending, valves 3 or 4 slightly below rim level to slightly exserted. *Seed* compressed-ovoid, 1.2–2.0 mm long, slightly glossy, dark grey-brown to black, with a finely pitted reticulum; chaff glossy, reddish.

Etymology

The epithet is from the English *exposed* and the name has two intented meanings, the first referring to its exposed habitat on high altitude peaks and the second referring to the fact that until recently this taxon has been largely uncollected by botanists.

Selected specimens (North to south)

SOUTH AUSTRALIA: Flinders Ranges Region: Summit of Mount Mary (sic), Wilpena Pound, 25.vi.1978, *A. Robinson s.n.* (AD); Tanderra Saddle, Wilpena Range (sic), 24.v.1986, *M.I.H. Brooker 9305, 9306, 9307* (AD, CANB); Tanderra Saddle, south-east of St. Mary Peak, Wilpena Pound, Flinders Ranges, 22.ix.1973, *A.J.A. Sikkes & P. Ollerenshaw 739, 740* (AD); Wilpena, Flinders Ranges, x.1958, *M.I.H. Brooker s.n.* (AD); Near top of Point Bonney, Wilpena Pound Range, altitude 1100 m, 12.vi.1992, *D. Nicolle 439* (AD); Near top of Point Bonney, Wilpena Pound Range, altitude 1100 m, (Juveniles), 12.vi.1992, *D. Nicolle 440* (AD, CANB); Top of Illuka Hill, Wilpena Pound Range, altitude 1050 m, 12.vi.1992, *D. Nicolle 441* (AD); Wilpena Pound, Moonarie Gap, (rock climbing area) 13°36' S, 138°37' E, 2.xi.1985, *P.J. Lang 8793, 8794, 8795* (AD); Mt Aleck, 100 m north of summit, Elder Range, 13.xi.1993, *D. Nicolle 565* (AD); Summit of Mt Aleck, Elder Range, 13.xi.1993, *D. Nicolle 563* (AD).

Distribution

Known only from the Elder Range and Wilpena Pound Range in the northern Flinders Ranges of South Australia. It occurs on the upper slopes and summit of peaks above about 1000 metres altitude such as Mt Aleck in the Elder Range and Point Bonny and St Mary Peak in the Wilpena Pound Range. It is the dominant eucalypt on the summit of these peaks, often associated with *E. flindersii* and *Xanthorrhoea quadrangulata*. Further down slope, *E. flindersii* or *E.* affinity *viridis* become the dominant eucalypt species.

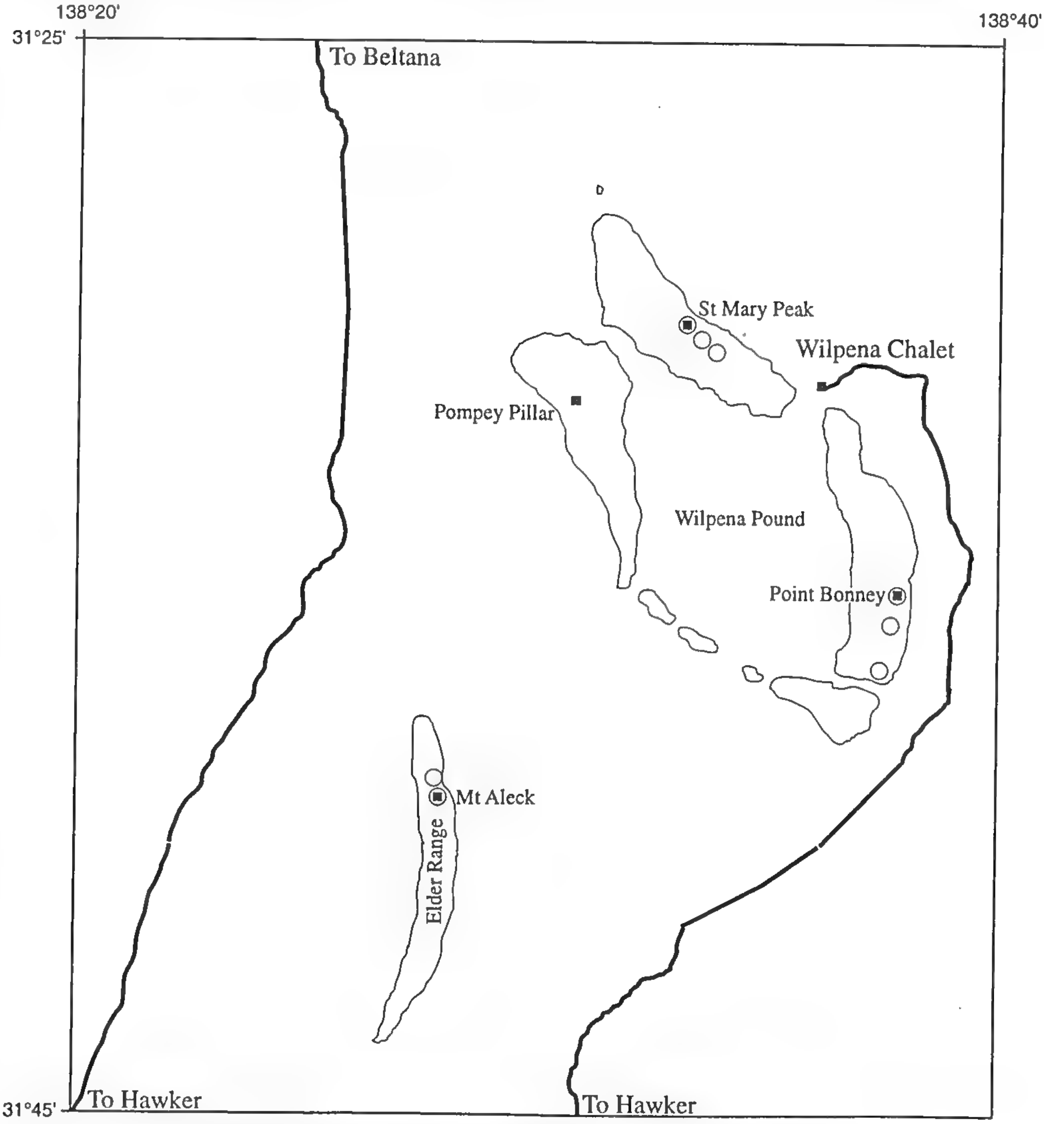
Flowering period: Not known.

Notes

E. goniocalyx subsp. *exposa* is distinguishable from subsp. *goniocalyx* by the mallee habit, less extensive or absence of rough bark, smaller juvenile leaves with shorter internodes, smaller and duller adult leaves and the variably pruinose branchlets, buds and fruits. *E. goniocalyx* subsp. *exposa* is somewhat variable in pruinosity and adult leaf colour, however, the adult leaves are never the glossy, green colour characteristic of subsp. *goniocalyx*. The geographically nearest known populations of *E. goniocalyx* subsp. *goniocalyx* to subsp. *exposa* in South Australia are on and around Mt Brown east of Port Augusta in the southern Flinders Ranges. Here, as with subsp. *goniocalyx* elsewhere, they form trees displaying no pruiniosity and with adult leaves that are glossy and dark green. In morphology, *E. goniocalyx* subsp. *exposa* also approaches *E. nortonii* (an endemic to New South Wales and Victoria) but the former can be distinguished from the latter by the mallee habit, less extensive rough bark, more variable but usually weaker pruinosity, the smaller, more crowded juvenile leaves with shorter internodes, the much smaller, greener adult leaves and the usually smaller buds and fruits. The geographically nearest populations of *E. nortonii* to *E. goniocalyx* subsp. *exposa* are around Maryborough in Victoria, over 500 km away where they occur at relatively low altitudes in undulating hills. In some characters *E. goniocalyx* subsp. *exposa* is intermediate between subsp. *goniocalyx* and *E. nortonii*, but it is most probable that *E. goniocalyx* subsp. *exposa* evolved from the geographically much nearer subsp. *goniocalyx*.

Conservation status

The populations are small and restricted, however they occur in inaccessible terrain and the taxon is sometimes dominant where it occurs. The Wilpena Pound populations are conserved within the Flinders Ranges National Park, and the Elder Range populations are unconserved. Plants recover vigorously in the event of a fire. The conservation status 2RCa is recommended using criteria of Briggs and Leigh (1996).



Map 2. Distribution of **Eucalyptus goniocalyx** subsp. **exposa** (O) showing 750 metre contours.

Eucalyptus informal sect. **Adnataria** Pryor & Johnson, *A Classification of the Eucalypts* (1971).

This section is predominantly distributed in eastern Australia and includes all the eucalypts commonly known as 'boxes' and 'ironbarks'. The section is composed of many series, most of which are poorly defined, and the section as a whole is considered

taxonomically difficult. Chippendale (1988) included *E. lansdowneana* (with subspp. *lansdowneana* and *albopurpurea*) in *E.* ser. *Porantheroideae* (Maiden) Chippendale, along with *E. petraea*, *E. thozetiana* and the type of the series, *E. ochrophloia*. *E.* ser. *Porantheroideae* is here taken to include only *E. ochrophloia* and *E. thozetiana*. *E. petraea* is considered more accurately placed in *E.* ser. *Lucasianae* Chippendale. *E. lansdowneana* subsp. *albopurpurea* is here raised to specific status and included in *E.* ser. *Subbuxeales* closest to *E. odorata* while the typical form of *E. lansdowneana* is considered taxonomically isolated within the section and a new monotypic series is erected to accommodate it.

Eucalyptus ser. **Subbuxeales** Blakely, *Key Eucalypts* 54, 233 (1934).

Type: *E. odorata* Behr.

A poorly defined series, composed of a number of taxonomically difficult taxa. *E. albopurpurea* is best placed in *E.* ser. *Subbuxeales*, its closest relative being that of the type species, *E. odorata*.

3. Eucalyptus albopurpurea (Boomsma) Nicolle, *stat. et comb. nov.*

Eucalyptus lansdowneana F. Muell. and J. E. Brown subsp. *albopurpurea* Boomsma, *S. Austral. Naturalist* 48: 55 (1974): **Basionym**

Type: South Australia, 4 km E of Kellidie Bay, 34°40'S, 135°30' E, 2.vii.1973, *R.A. Dorward s.n.* (holo: AD; iso: AD, CANB).

Eucalyptus behriana var. *purpurascens* F. Muell. ex Benth., *Fl. Australia* 3: 214 (1967); *Eucalyptus hemiphloia* var. *purpurascens* (F. Muell. ex Benth.) Maiden, *Trans. & Proc. Roy. Soc. S. Australia* 26: 12 (1902); *Eucalyptus odorata* var. *purpurascens* (F. Muell. ex Benth.) Maiden, *Trans. & Proc. Roy. Soc. S. Australia* 32: 283 (1908).

Type: Lake Wangarry, S.A., *C. Wilhelmi s.n.* (iso: MEL).

Eucalyptus lansdowneana var. *leucantha* Blakely, Key *Eucalypts* 224 (1934).

Type: South Australia, between Kirton Point and Port Lincoln, -.i.1907, *J.H. Maiden s.n.* (holo: NSW).

Mallee or less commonly a tree 5 to 18 m tall. *Bark* rough at base or for up to 2.5 metres, loose, grey-brown, becoming ribbony then smooth thereafter, grey or olive-grey over coppery or pinkish-tan, decorticating in strips. Forming *lignotubers*. *Branchlets* with pith glands present only at nodes. *Cotyledons* reniform. *Seedling leaves* opposite for 2 or 3 pairs then alternating, petiolate, ovate, 35–60 mm long × 23–35 mm wide, discolorous, dull, green. *Adult leaves* alternating, petiolate, (ovate to) broad-lanceolate (to lanceolate), 70–130 mm long × 22–35 mm wide, concolorous, glossy, green; reticulation dense but broken, oil glands scattered, mostly intersectional, lateral veins at 35° to 55° from midrib. *Inflorescences* axillary or appearing terminal through abortion of terminal leaf shoots, unbranched, 7- to 11-flowered; peduncles slightly flattened to terete, 10–14 mm long; pedicels 0.1–3 mm long. *Buds* fusiform to clavate, 7–11 mm long × 3–5 mm diam., hypanthium smooth or angled towards base, operculum equal in width to hypanthium, smooth, conical, apiculate; both opercula held until flowering. *Stamens* variously flexed, all fertile; anthers adnate, basifixed, globoid, opening by lateral pores, white to pink to purple. *Ovules* in 4 vertical rows. *Fruits* pedicellate, barrel-shaped to cupular, smooth, angular towards base of hypanthium, 6–11 mm long × 5–9 mm diam.; operculum scar to 1 mm wide, ascending or almost level; disc descending, valves 3 or 4 enclosed or to rim level. *Seed* compressed-ovoid, 1.0–1.5 mm long, dull, brown to brown-grey, with a fine to moderately pitted reticulum; chaff slightly glossy, orange brown.

Distinguished from *E. lansdowneana*, as now circumscribed, by the larger and more robust habit; non-pendulous crown; broad-lanceolate, dark green adult leaves which are often dull when immature; usually smaller buds and fruits; white, pink or purple staminal filaments that are all fertile, and the coastal habitat.

Other specimens examined (West to east)

SOUTH AUSTRALIA: Eyre Peninsula Region: Kellidie Bay Conservation Park, NW corner, 1.9 km N along road to Wangarry from the Coffin Bay - Port Lincoln road intersection, 17.ix.1983, *J.D. Briggs 1197* (AD, NSW, CANB); 34°48'27"S, 135°45'45"E, (Just north of Sleaford Mere, south-west of Port Lincoln), 16.xii.1995, *D. Nicolle 1609* (AD); 34°50'23"S, 135°41'54"E, (West of Sleaford Mere, south-west of Port Lincoln), 17.vii.1994, *D. Nicolle 942* (AD); 34°50' 43"S, 135°43' 36"E, (West of Sleaford Mere, south west of Port Lincoln), 17.vii.1994, *D. Nicolle 940* (AD); Fishery Bay - coastal cliff top, 22.x.1977, *P.J. Lang 1120* (AD). Kangaroo Island Region: 15 km N of Cape de Couedic, 7.ii.1981, *M.D. Crisp 595* (AD); 3 km E of Seal Bay, 6.iii.1977, *P.J. Lang 695* (AD); 35°58'35"S, 137°12'02"E, (South Coast Road, just north-east of Vivonne Bay, K.I.), 29.iv.1994, *D. Nicolle 802* (AD); 1 km NE Eleanor Station on South Coast Road, 20.vii.1975, *G. Chippendale 1363 & M.J. Brennan s.n.* (AD); 35°49'54"S, 137°42'08"E, (Three Chain Road, south-west of American River, K.I.), 29.iv.1994, *D. Nicolle 793* (AD); 35°49'56"S, 137°57'31"E, (Near Wilson River Homestead on Wilson River, K.I.), 25.ix.1994, *D. Nicolle 1060* (AD).

Distribution

E. albopurpurea is endemic to South Australia, known only from Kangaroo Island and the southern tip of Eyre Peninsula. It is a coastal taxon, sometimes occurring within a few metres of the high tide water level on sandhills, for example with *E. diversifolia* on the south coast of Kangaroo Island. It appears to be tolerant of saline soils indicated by mallees of this species growing naturally on the edge of Sleaford Mere on Eyre Peninsula. *E. albopurpurea* grows in areas of slightly higher rainfall than the closely related *E. odorata* (500-650 mm annually; 300-600 mm for *E. odorata*). *E. albopurpurea* is often associated with a variety of mallee and coastal woodland species such as *E. rugosa*, *E. diversifolia*, *E. incrassata* var. *angulosa*, *E. cneorifolia*, *E. leucoxylon*, *E. cosmophylla*, *E. leptophylla*, *E. fasciculosa*, *E. odorata*, *E. oleosa* and *E. cladocalyx*.

Flowering period: March to October.

Notes

E. albopurpurea is most closely related to *E. odorata*, with a much more distant relationship to *E. lansdowneana*, a whipstick mallee restricted to a few small populations in the western part of the Gawler Ranges. *E. albopurpurea* and *E. lansdowneana* are allopatric, occurring over 250 kilometres apart in vastly different habitats. *E. albopurpurea* and *E. odorata* intergrade on central-eastern Kangaroo Island where their distributions overlap, and possibly also in the Wanilla area of Eyre Peninsula. *E. albopurpurea* is therefore best placed in *E.* ser. *Subbuxeales* Blakely nearest *E. odorata*. Plants of *E. albopurpurea* on Eyre Peninsula are generally lower growing with a more straggly habit compared to plants on Kangaroo Island which sometimes attain tree proportions, and Eyre Peninsula plants more often have coloured filaments (pink to purple) whereas Kangaroo Island plants usually have white filaments or more rarely coloured filaments. The adult leaves of the Kangaroo Island plants also remain dull in the crown for longer before becoming glossy. These slight differences are not considered to warrant taxonomic distinction.

Conservation status

Common and well conserved, occurring within Flinders Chase National Park and Kelly Hill, Vivonne Bay, Seal Bay and Cape Gantheaume Conservation Parks on Kangaroo Island and Lincoln and Coffin Bay National Parks on Eyre Peninsula.

Eucalyptus ser. **Vagitae** Nicolle, *ser. nov.*

Frutices "mallees", ramuli flexuosi, penduli. Cortex interdum fibrosus basin versus vel omnino laevis, taeniis decorticantibus. Lignotuberum formans. Cotyledones reniformes. Medulla non glandulifera. Folia juvenilia petiolata, remanentia opposita per nodos paucos, tum alternantia, ovata ad late lanceolata, discoloria, hebetia, viridia. Folia adulta petiolata, alternantia, lanceolata vel falcata, concoloria, valde nitentia, flavido-viridia ad

viridia, glandibus oleosis paucis vel moderate dispersis, irregularibus in ambito. Inflorescentiae axillares vel apparenter terminales, saepe in ramulis non foliosis, non ramosae, 7-floribus. Flores rutili. Filamenta staminum inflexa, exteriora sine antheris (staminodiis), antherae adnatae, basifixae, dehiscentes per poros laterales. Alabastra pedicellata, clavata, 1 ad 3 costatis longitudinalibus vel angulis, operculum conicum, operculo externo persistenti vel cadens in anthesin. Ovarium 4 vel 5-loculare. Ovula verticaliter 4-seriata. Fructus pedicellati, doliiformes vel suburceolati, 1 ad 3 costatis longitudinalibus vel angulis, valvis inclusis, discus decendens. Semina compresso-ovoidea, atrocinereo-brunnea vel nigra

Typus: *Eucalyptus lansdowneana* F. Muell. & J. Brown.

Mallees, branches flexuous and pendulous. *Bark* sometimes rough at base, usually completely smooth, decorticating in strips. Forming lignotubers. *Cotyledons* reniform. Pith glands absent. *Juvenile leaves* petiolate, remaining opposite for 2–4 pairs then alternating, ovate to broad-lanceolate, discolorous, dull, green. *Adult leaves* petiolate, alternating, lanceolate or falcate, concolorous, very glossy, yellow-green to green, oil glands sparse to scattered, irregular in shape. *Inflorescences* axillary or appearing apparently terminal through abortion of terminal leaf shoot, often on leafless section of branchlets, non-branched, 7-flowered. *Flowers* red. *Staminal filaments* inflexed, outer ones without anthers (staminodes), anthers adnate, basifixed, opening by lateral pores. *Buds* pedicellate, clavate, with 1–3 longitudinal ribs or angles, operculum conical, outer operculum persistent or outer shed just before anthesis. *Ovary* 4 or 5-locular. *Ovules* in 4 vertical rows. *Fruits* pedicellate, barrel-shaped to slightly urceolate, with 1–3 longitudinal ribs or angles, valves included, disc descending. *Seeds* compressed-ovoid, dark grey-brown to black with a fine to moderately pitted reticulum.

Etymology

From the Latin *vagitus* (to weep, squall) referring to the straggly, pendulous habit of the only species in the series.

Notes

E. ser. *Vagitae* is a monotypic series distinguished within *E.* sect. *Adnataria* by its combination of mallee habit, pendulous branches, very glossy, yellow-green to green leaves, red staminal filaments, outer stamens lacking anthers (staminodes) and large ribbed buds and fruits. The pendulous habit and red flowers are unique within *E.* sect. *Adnataria*.

E. ser. *Vagitae* is probably most closely related to *E.* ser. *Lucasianae* Chippendale, which shares with *E.* ser. *Vagitae* the mallee habit and staminodes but can be easily distinguished by the non pendulous habit, white staminal filaments and the much smaller, smooth buds and fruits. *E.* sect. *Adnataria* is predominantly eastern in distribution and diversity with only two series endemic outside the eastern states, viz. *E.* ser. *Lucasianae* containing *E. petraea*, *E. lucasii*, *E. cuprea* and *E. absita* (all Western Australian endemics) and the monotypic *E.* ser. *Vagitae* (*E. lansdowneana*).

4. Eucalyptus lansdowneana F. Muell. & J. Brown, *Forest Fl. S. Aust.* 9: t. 44 (1890).

Type citation: Pandura Run, SA., 1889, *T.L. Browne s.n.* (holo: AD; iso: AD, NSW).

Mallee, 2 to 5 m tall, of straggly habit, branches flexuous and pendulous. *Bark* rough for up to 1 metre on larger mallees, loose, grey-brown, then smooth, often smooth throughout, grey to tan over cream, decorticating in strips. Forming *lignotubers*. *Branchlets* with pith glands absent. *Cotyledons* reniform. *Seedling leaves* opposite for 2–4 pairs then alternating, petiolate, ovate to broad-lanceolate, 35–60 mm long × 22–35 mm wide, discolorous, dull, green. *Adult leaves* alternating, petiolate, lanceolate or falcate, 90–180 mm long × 14–30 mm wide, concolorous, very glossy, yellow-green to green; reticulation moderate, oil glands sparse to scattered, island and intersectional, irregular in shape, lateral veins at 30° to 45° from midrib. *Inflorescences* appearing terminal through abortion of terminal leaf

shoots, often on leafless sections of branchlets, unbranched, 7-flowered; peduncles slightly flattened to angular, 5–16 mm long; pedicels 2–5 mm long. *Buds* clavate, 10–14 mm long × 5–7 mm diam., hypanthium with a few longitudinal ribs or angles, operculum equal in width to hypanthium, smooth, or sometimes with ribs or angles extending from hypanthium, conical; both opercula held until flowering or outer operculum shed just before anthesis. *Stamens* inflexed, outer stamens without anthers (staminodes); anthers adnate, basifixed, globoid, opening by lateral pores. *Flowers* crimson-red fading to pink. *Ovules* in 4 vertical rows. *Fruits* pedicellate, cylindrical to slightly urceolate, with 1-3 longitudinal ribs or angles, 8–12 mm long × 7–12 mm diam.; operculum scar to 0.1 cm wide, ± level; disc descending, valves 4 or 5, enclosed. *Seeds* compressed-ovoid, 1.3–1.7 mm long, dark grey-brown to black with a fine to moderately pitted reticulum.

Distinguished from *E. albopurpurea* by the open, more straggly habit; pendulous branches; longer, lanceolate to falcate, very glossy, yellow-green to green adult leaves; larger buds and fruits; red staminal filaments with outer filaments lacking anthers; and the inland, rocky hillslope habitat.

Other specimens examined

SOUTH AUSTRALIA: Eyre Peninsula Region: Yandinga Gorge, ca 35 km N of Minnipa, 26.iv.April 1969, *A.E. Orchard 2227* (AD); 5 km SE of Kododo Hill, -.ix.1972, *D.N. Kraehenbuhl 2620* (AD); Gawler Ranges, 16 km S of Yardea HS on road to Minnipa & ± opposite Conical Hill, 4.x.1972, *D.E. Symon 8158* (AD); 30.4 km from Chilpuddie Tank towards Yardea Station, 30.iii.1977, *M.I.H. Brooker 5591* (AD,CANB, MEL, NSW); Vicinity of Kododo Hill (17.6 km SW from junction of Yardea - Hiltaba road on Yardea - Minnipa road. Hill slopes W of road), 13.x.1977, *P.J. Lang 973* (AD, CANB, NSW); Gawler Ranges - on hill SW of Scrubby Peak, 16.vi.1983, *D.F. Blaxell 2052 & L. Johnson* (AD, CANB, PERTH); 18.6 km SW of Yardea Homestead along road to Minnipa, 3.ix.1983, *J.D. Briggs 1116* (AD, CANB, MEL, NSW); Gawler Range, Valley S of Scrubby Peak, SW slope of hill, 7.vi.1985, *D.R. Greenwood 59* (AD, CANB); Scrubby Peak, Gawler Ranges, -.ix.1991, *D. Nicolle 57* (AD); 32°28'18"S, 135°23'24"E, (South-west of Yardea on W side of road, Gawler Ranges), 15.ii.1996, *D. Nicolle 1678* (AD).

Distribution

E. lansdowneana is restricted to the higher, south-western part of the Gawler Ranges on upper Eyre Peninsula and is endemic to South Australia. It grows on the slopes and tops of various hills bounded by Kododo Hill, Conical Hill, Paney Bluff and the hills south-west of Scrubby Peak. It is usually found occurring in somewhat pure stands with various shrubs although occasionally it is seen growing with one or more of the following eucalypts: *E. porosa*, *E. phenax* subsp. *phenax*, *E. gracilis* and *E. socialis*.

Flowering period: Sporadic and recorded for all months of the year, most commonly June to October.

Notes

E. lansdowneana is isolated in *E.* sect. *Adnataria*, with no known close relatives. It is distinctive within the section because of its very open, pendulous crown and crimson flowers. The only other box species known to grow within the range of *E. lansdowneana* is *E. porosa*, which generally grows on the footslopes below *E. lansdowneana*. It is easily distinguished from *E. lansdowneana* among other characters by its larger, more robust stature and white flowers.

Conservation status

Of very restricted occurrence and not known to occur in a conservation reserve. The conservation code 2R, as given by Briggs & Leigh (1996) is appropriate.

Acknowledgments

I would like to thank the staff of the State Herbarium of South Australia for continuing support and access to the herbarium facilities, Ian Brooker for general discussions and advice on many aspects of eucalypt taxonomy and for checking and commenting on the manuscript and Peter Lang for discussions and comments regarding *E. phenax*.

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J. Adelaide Bot. Gard. 19: 95–96 (2000)

A RE-EVALUATION OF *CASSIA OLIGOPHYLLA* VAR. *SERICEA* SYMON (CAESALPINIACEAE)

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Abstract

In Randell (1989) *Cassia oligophylla* F. Muell. var. *sericea* Symon was synonymised with *Senna artemisioides* (DC.)Randell subsp. *oligophylla* (F. Muell.)Randell. However, field experience in the Northern Territory and Western Australia indicates that the taxon is consistently recognisable. To assist those who wish to distinguish this taxon it is here reinstated under the new combination *Senna sericea* (Symon)Albr. & Symon.

Taxonomic history

Cassia oligophylla var. *sericea* was described by Symon (1966). The taxon appears to have been accepted by Australian herbaria until Randell (1989) reduced *C. oligophylla* var. *sericea* to a synonym of *Senna artemisioides* subsp. *oligophylla*. In the recent *Flora of Australia* account of *Senna* (Randell & Barlow, 1998) *Cassia oligophylla* var. *sericea* is included as a synonym of *Senna* form taxon '*oligophylla*' with no reasons given for the change.

Distinctiveness and rank

S. sericea has leaflets with a silvery or golden satiny indumentum, giving plants a striking appearance in both the field and herbarium. The leaflet indumentum is composed of persistent, dense, appressed hairs that completely obscure the underlying leaflet surface. Leaflet indumentum is the most diagnostic character separating *S. sericea* from its closest allies *S.* form taxon '*oligophylla*' and *S.* form taxon '*alicia*'.

S. form taxon '*oligophylla*' has a variable leaflet indumentum, which is presumably why Randell (1989) and Randell & Barlow (1998) include *C. oligophylla* var. *sericea* within it. Most specimens of *S.* form taxon '*oligophylla*' studied by the present authors could be sorted into one of two forms on the basis of leaflet indumentum—a form with short straight or curved hairs spreading from the leaflet surface, and a form with appressed hairs. In addition, a considerable number of specimens possess somewhat wavy hairs suggesting possible intergradation with *S.* form taxon '*helmsii*'. Of these forms, only the one with appressed hairs could be confused with *S. sericea*. Some specimens of this form have a thinly sericeous indumentum on new growth. However, in almost all cases it is readily distinguished from *S. sericea* by the thinner indumentum that becomes sparser as leaflets mature exposing the leaflet surface between hairs. *S.* form taxon '*oligophylla*' has 2–3 pairs of leaflets whereas *S. sericea* has 1–2 pairs of leaflets.

With regard to leaflet number and spacing, *S.* form taxon '*alicia*' resembles *S. sericea*, the former having 1–2 (rarely 3) pairs of leaflets, spaced 3–12 mm apart when 2 pairs of leaflets are present. The presentation of the leaflets, with the adaxial surface of opposing leaflets facing each other, considered by Randell & Barlow (1998) as a useful diagnostic characteristic of *S.* form taxon '*alicia*', is also sometimes found in *S. sericea*. However, *S.*

form taxon '*alicia*' has glabrous or sparsely hairy leaflets 5–12 (-15) mm wide, compared with (8-) 10–22 (-30) mm wide in *S. sericea.*

S. sericea occurs over a considerable geographic range and sometimes occurs with other taxa previously classified as subspecies of *S. artemisioides*. For example at 'The Granites' in the Tanami Desert, Northern Territory, *S. sericea* occurs with *S.* form taxon '*oligophylla*', *S.* form taxon '*helmsii*' and *S. symonii.*

Possible hybrids between *S. sericea* and *S.* form taxon '*oligophylla*' appear to be rare, though extensive field studies of mixed populations have not been undertaken

Given its large geographic range, distinctive indumentum and plant uniformity we have opted to recognise *S. sericea* at specific rank. The rank is congruent with the recent *Senna* treatment by Randell & Barlow (1998), where species rank is reserved for those taxa showing little or no evidence of intergradation.

Senna sericea (Symon)Albr. & Symon, *comb. et. stat. nov.*

Cassia oligophylla var. *sericea* Symon, *Trans. Roy. Soc. S. Australia* 90: 113 (1966), **basionym.**

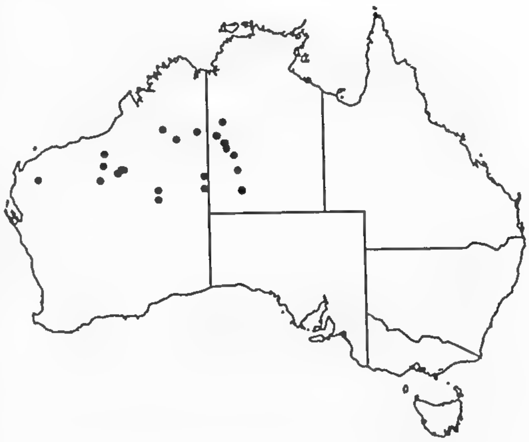

Fig. 1. Distribution of *Senna sericea.*

Type: "The Granites", Northern Territory, 14.viii.1936, *J.B. Cleland s.n.* (holo: AD).

Distribution

This species occurs in the western parts of central Northern Territory and more extensively in arid Western Australia.

Habitat

Occurs almost exclusively on gravelly or rocky hills and rises, occasionally extending on to adjacent plains. The underlying parent rock at known sites includes chert, laterite, quartz, sandstone and limestone. In the Northern Territory associated species include *Acacia pruinocarpa, A. hilliana, Senna symonii, S.* form taxon '*oligophylla*', *S.* form taxon '*pruinosa*', *Triodia pungens, T. intermedia* and *T. spicata.*

Selected specimens (38 specimens examined)

WESTERN AUSTRALIA: *A. Mitchell,* 22.vi.1996, 79.8 km from Newman, 23°23'33", 120°31'16" (AD, PERTH).

NORTHERN TERRITORY: *P.K. Latz 11809*, 24.ix.1990, 3 km SSW of Tanami Bore (AD, DNA, MEL, MO, NSW, NT).

Acknowledgments

We wish to thank Jim Ross for clarifying some nomenclatural issues; Malcolm Trudgen and Andrew Mitchell for information on Western Australian populations; and the curator of PERTH for the loan of specimens.

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A NEW GYPSOPHILOUS *GOODENIA* (GOODENIACEAE)

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Abstract

Goodenia gypsicola Symon a new *Goodenia* confined to consolidated gypsum is described and figured, six collections are known.

Goodenia gypsicola Symon, *sp. nov.*

Herba perennis, radice palari fortique, brachyblastis multis brevibus apice confertis. *Folia* spathulata 8 × 1 cm, pleraque 5 × 0.5 cm, integra aut 2-3 lobis parvis, minute pubescentia comis simplicibus et glandulosis. *Inflorescentia* caudis erectis filo metallico similibus, simplex aut breviter ramosa. *Bracteae* anguste oblongae. *Pedunculi* filiformi et declinati, articulati 1 mm sub calice. *Lobi calicis* triangulares. *Corolla* 6 mm longa, lobi anguste alati, sublazulina. Indusium 1 × 1 mm bruneo-vinosum, orificio setis brevibus. *Capsula* globularis 1.5 mm diam. *Semina* plurima 0.25 mm longa, angulare-obovoidea et vitrea, ala obscura.

Type: Western Australia, Austin Botanical District 10.7 km NW of Menzies on Sandstone road. Common. Calcrete island in salt lake. *Casuarina / Grevillea* shrubland on powdery pale yellow brown loam. Small tufted perennial with very rigid inflorescences. Flowers very pale blue. 30.x.1993 *R.J. Chinnock 8586 & G.S. Richmond* (*holo*: AD, *iso.* (*n.v.*): PERTH, NSW).

Perennial herb with well developed tap root and numerous short shoots at ground level forming rounded tufts to 6 cm high and 8 cm diam., larger plants may have 100 leaves. Young growths minutely pubescent with simple and sessile glandular hairs (lens needed), mature leaves glabrescent or with a few hairs persisting on the lobe tips, longer white hairs persist in the leaf axils and may be conspicuous. *Leaves* spathulate, to 3 × 1 cm, commonly c. 5 × 0.5 cm, tapering to an indistinct petiole, apex acute or obtuse, entire or larger leaves with 2–3 blunt shallow lobes towards the apex. *Inflorescence* of erect wiry stems to 35 cm long commonly 20 cm, simple or shortly branched, up to 30 stems on a well grown plant. *Bracts* green, 10–30 × 1 mm, linear-oblong, each subtending a single flower. *Peduncles* filiform, 5 mm, deflexed, without bracteoles, articulation 1 mm below ovary. *Calyx* tube obconical, 1.5 mm long, adnate to the ovary, calyx lobes triangular, 1 mm long, adnate for c. 0.5 the length of the ovary. *Corolla* c. 6 mm long, the lobes narrowly winged, adaxial lobe wings unequal, pale blue, pubescent with simple hairs in the throat and on the lower parts of the corolla tube outside. *Filaments* 2 mm long, anthers 1 mm long. *Ovary* near globular; with c. 30 ovules in two rows in each locule, style 2 mm, indusium shortly oblong 1 × 1 mm, purple brown, some simple hairs above and below, orifice with longer bristles on the upper lip. Seeds numerous 0.25 mm long, angular obovoid, wing not obviously reduced to a subpapillose margin, the faces of the seed smooth, glossy, light brown.

Distribution & ecology

This species has been collected from consolidated gypsum in the Serpentine Lakes area of South Australia and from a salt lake system in Western Australia.

Conservation status

Although seemingly rare and confined to a specialised habitat the species does not seem under threat.

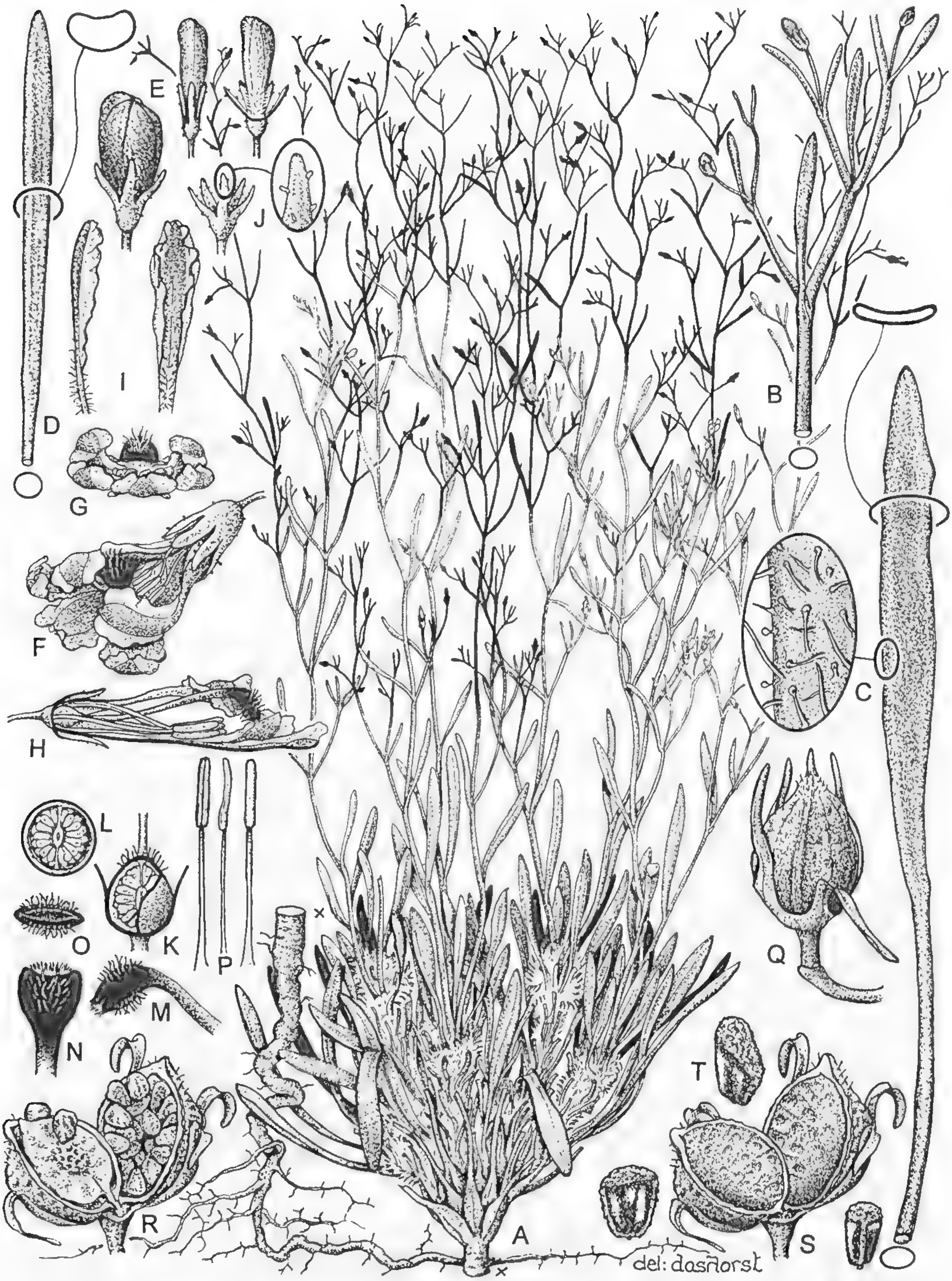

Fig. 1. ***Goodenia gypsicola*** Symon (**A–T**, *R.J. Chinnock 8586 & G.S. Richmond*). **A,** whole plant ×1; **B,** portion of branching ×2; **C,** lower leaf and margin ×3; **D,** stem leaf ×5; **E,** flower buds ×6; **F,** flower reconstituted ×5; **G,** flower end on ×5; **H,** flower lateral view ×5; **I,** corolla lobes ×5; **J,** calyx & lobe tip ×5; **K,** ovary × 15; **L,** ovary transverse section ×15; **M,** indusium lateral view ×10; **N,** indusium - upper surface ×10; **O,** indusium - orifice ×10; **P,** stamens ×10; **Q,** capsule mature ×10; **R,** capsule and seeds ×10; **S,** capsule empty ×10; **T,** mature seeds ×25.

Etymology

The specific epithet is derived from the gypseous sites on which the species has been found.

The new species may be incorporated into the key to *Goodenia* in the *Flora of South Australia* 3 (1986) 1388 as follows:

GROUP A

1. Bracteoles present, leaves 10–25 cm long, 2–5 cm wide, serrulate to dentate .... *G. ramelii*
1. Bracteoles absent; leaves less than 10 cm long and 1 cm wide, entire or with a few small teeth.
    2. Leaves villous, lanceolate-elliptic, seeds flat with broad wing.. *G. vilmoriniae*
    2. Leaves glabrous with some axillary hairs, spathulate, seeds vitreous, unwinged .... *G. gypsicola*

Specimens seen

AUSTRALIA. WESTERN AUSTRALIA: *R.J. Chinnock 8586 & G.S. Richmond*, 10.7 km NW of Menzies on the Sandstone Road, 30.x.1993 (AD, NSW, PERTH). *D. Nicolle 2671*, 185 km West of the WA-SA border towards Neale Junction on Anne Beadell highway 28°19'28", 127°19'31", growing on pure gypseous outcrops near small dry clay pans, with some *Eucalyptus concinna* and *Eucalyptus* aff. *leptophylla* on slightly less gypseous sites (AD, PERTH).

SOUTH AUSTRALIA: *C.R. Alcock 8289*, Great Victoria Desert, Nat. Cons. Soc. S. Aust. Survey, Camp 6, Serpentine Lakes, 164 km W of Vokes Hill junction, 25.xiii.1980 (AD). *D.E. Symon 12605*, Great Victoria Desert, banks of Serpentine Lakes where the road crosses the lake. Common on pure gypseous slopes, only plant in many places, no flowers anywhere, 28.viii.1980 (AD, PERTH, SYD-U). *G. White s.n.*, Serpentine Lakes. Bromeliad (sic) type plant inhabiting kopi slopes of Lakes region, 26.v.1993 (AD). *D. Nicolle 2660*, east bank of Serpentine Lakes on Anne Beadell highway, 28°30'06", 129°01'26". Growing on gypseous slopes with some *Casuarina pauper*. Very common here but not seen at all in red sand above this slope overlooking lake, 9.vii.1999 (AD, CANB, K, PERTH).

Acknowledgments

I am grateful to Mary Marlow for the Latin description and to Leigh Sage (PERTH) for helpful comments.

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BOOK REVIEW

Plant Life in the World's Mediterranean Climates. California, Chile, South Africa, Australia, and the Mediterranean Basin. Peter R. Dallman (1999). Hardback, pp. 258, photographs (colour, black and white), line drawings. $95.00. Oxford University Press.

This book uses the engaging idea of comparing the floras of the five separately located mediterranean climates of the world: the Mediterranean Basin from which the climate derives its name, the Western Cape of South Africa, California, Central Chile and the Southern Coast of Australia. These areas are widely separated but lie between 30° and 40° of latitude.

There is a general resume of the legacy of continental break up, which notes the formation of the Northern and Southern Hemisphere. Eurasia and its relationship with North America is described. There are also direct comparisons of the Gondwanan floras especially those of South Africa and Southern Australia.

A detailed description of the weather patterns that define a mediterranean climate is provided supported by explanatory graphs and tables. The book also looks at the adjacent climates and their effects upon the mediterranean climate flora, such as the threat of recurrent fires caused by long periods of drought.

The evolution of the different floras is examined together with the conjectured historical reasons for such adaptations by specific taxa arising from tectonic movement, the subsequent climate change and its effect on the soil formation. The major plant communities of each location are analysed along with effects of the local climate and subtle landscape differences, which create unique microclimates. For example, one has described different plant communities such as the Kwongan and Mallee areas of Australia, the Fynbos and Strandveld of Africa, the Matorral and Coastal Matorral areas of Chile and the Chaparral and Coastal Scrub of California finishing with the Maquis and Garrigue of the Mediterranean Basin.

The arrangement in sections of the text on each plant community allows comparisons to be made of morphological similarities and various modifications, which species in the floras have adopted to survive in their respective environments. This is illustrated by named examples and cross-referenced to taxa with similar adaptations in their respective areas, for example the floras of Southern Africa and Southern Australia. Consequently, reasons are explained for defensive foliage modifications to prevent grazing, dimorphic adaptations to prevent water loss and why certain families have evolved geophytic genera in various locations.

Reference is made to the attraction and exploitation of these areas by mankind and the introduction of food plants, vines and other associated exotic taxa which find the climate so conducive. It is interesting to note listings of plants discussed from the Mediterranean Basin that have been used as garden ornamentals in other mediterranean parts of the world eg. from the Maquis *Arbutus unedo, Cercis siliquastrum, Ceratonia siliqua* and *Cistus salviifolius* have all been successfully cultivated. It also shows how some introduced species have caused problems of competition with the endemic species eg. *Olea europea, Genista hispanica, Lavandula stoechus* and *Rosmarinus officinalis* which now prove weedy and difficult to eradicate in certain locations.

There are many splendid photographic portraits and line drawings of the different plants and communities that create these unique floras. The five different regions and their flora are illustrated by spectacular photography. For example there is the architectural Bromeliaceae and the colourful autumn tints of *Nothofagus* from Chile; one is introduced to the various forms of *Protea* and the interesting range of *Erica* which can be found in South Africa. The Coastal Redwoods are displayed along with the flowering *Cercis occidentalis*

of California; interesting structures of Australian *Banksia* are displayed along with vast swathes of the deep blue *Lechenaultia biloba*, whilst finishing with the twisting branches of *Quercus pubescens* and the rock hugging *Cistus* of the Mediterranean Basin.

Dallman supplies a full and interesting list of references for those wishing to extend their reading. The author also includes a section on how to plan a trip to see these areas for oneself. This chapter supplies good information and directs one on how to partake in and enjoy these beautiful Mediterranean climate regions.

This book will inspire botanists and horticulturists, especially those engaged in public education in botanic gardens and other academic institutions. It also supplies the home gardener with an informative reference book to which they can refer.

John Sandham
Botanic Gardens of Adelaide.

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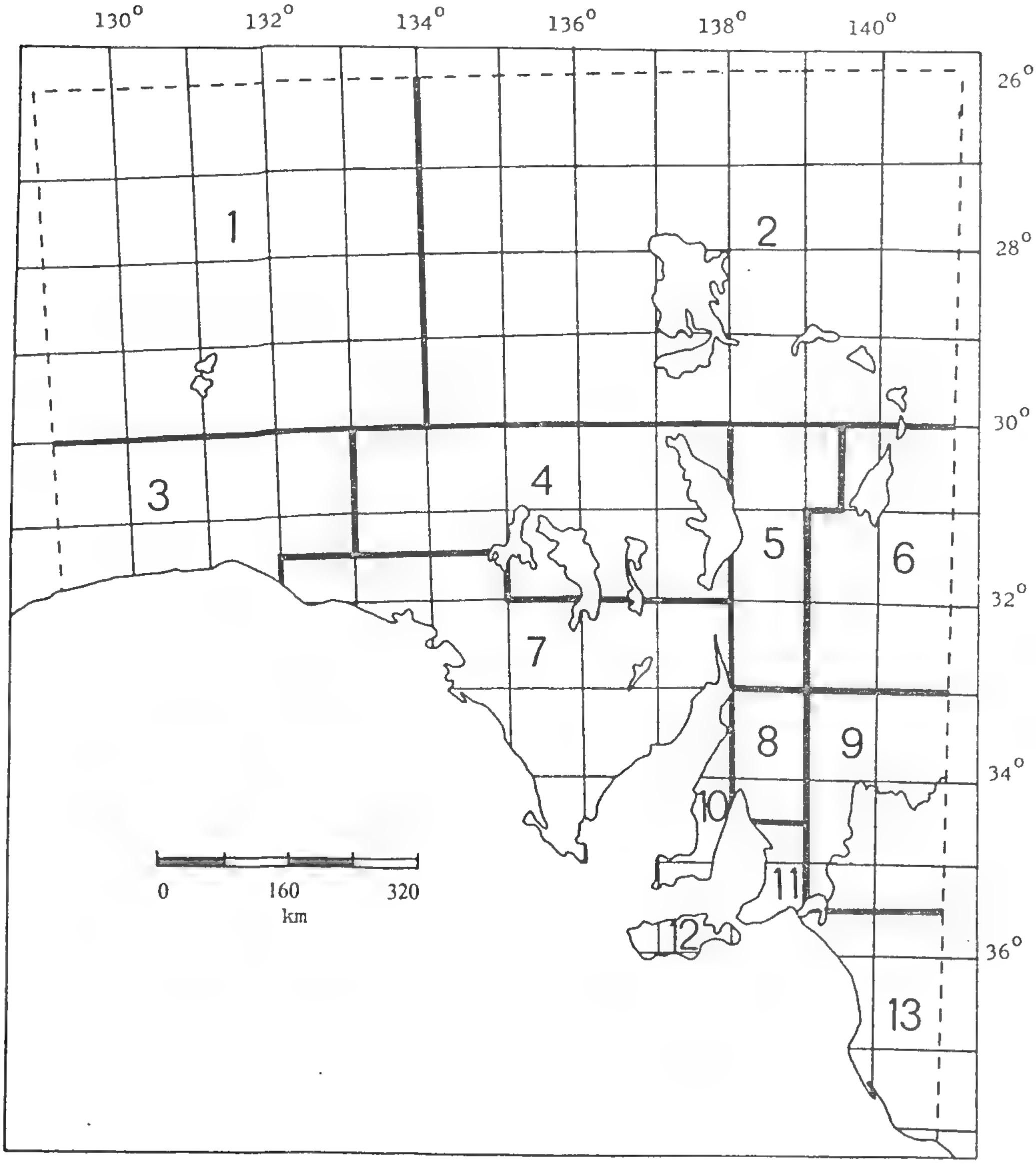
REGIONS OF SOUTH AUSTRALIA ADOPTED BY THE STATE HERBARIUM — ADELAIDE

1. North-western
2. Lake Eyre
3. Nullarbor
4. Gairdner-Torrens
5. Flinders Ranges
6. Eastern
7. Eyre Peninsula
8. Northern Lofty
9. Murray
10. York Peninsula
11. Southern Lofty
12. Kangaroo Island
13. South-eastern



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